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THE ULTIMATE IMAT COLLECTION

UniAdmissions

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THE ULTIMATE IMAT COLLECTION

Five Books in One

Dr Alex Ochakovski
Dr Rohan Agarwal

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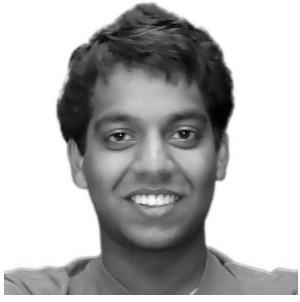
About the Authors

Alex is the co-founder and **Managing Director** at IMAT School, as well as the founder of MEDschool.it website. As a graduate of a first of a kind International Medical School in Italy, a former official supervisor of the IMAT test in Pavia and a dedicated curator of MEDschool.it, Alex has developed a deep understanding of the IMAT and the admission process over the years, following IMAT from the day it was created.

As an avid researcher with over ten peer-reviewed publications, experienced software developer, a fluent speaker of five languages and a medical doctor, Alex feels most fulfilled by combining his passions and strengths in projects that make a positive impact on society.

Thousands of current international medical students have been admitted to medical studies all over Italy with the help, guidance and resources he provides to this day, creating a country-wide network of contacts in every International Medical School in Italy.



Rohan is the **Director of Operations** at *UniAdmissions* and is responsible for its technical and commercial arms. He graduated from Gonville and Caius College, Cambridge and is a fully qualified doctor. Over the last five years, he has tutored hundreds of successful Oxbridge and Medical applicants. He has also authored ten books on admissions tests and interviews.

Rohan has taught physiology to undergraduates and interviewed medical school applicants for Cambridge. He has published research on bone physiology and writes education articles for the Independent and Huffington Post. In his spare time, Rohan enjoys playing the piano and table tennis.

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HOW TO USE THIS BOOK

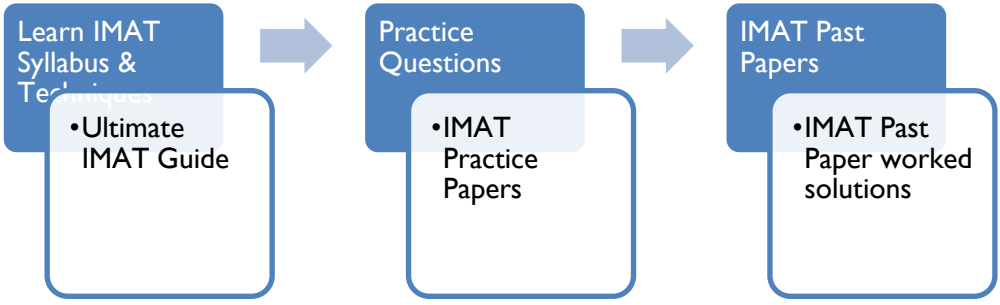
Congratulations on taking the first step to your IMAT preparation! The IMAT is a difficult exam and you'll need to prepare thoroughly in order to make sure you get that dream university place.

The Ultimate IMAT Collection is the most comprehensive IMAT book available – it's the culmination of five top-selling IMAT books:

- The Ultimate IMAT Guide
- IMAT Past Paper Worked Solutions: Volume 1
- IMAT Past Paper Worked Solutions: Volume 2
- IMAT Practice Papers: Volume 1
- IMAT Practice Papers: Volume 2

Whilst it might be tempting to dive straight in with mock papers, this is not a sound strategy. Instead, you should approach the IMAT using the three steps shown below. Firstly, start off by understanding the structure, syllabus and theory behind the test. Once you're satisfied with this, move onto doing the 600 practice questions found in The Ultimate IMAT Guide (not timed!)

Then, once you feel ready for a challenge, do each practice paper under timed conditions. Finally, once you've exhausted these, go through the past papers, start with the 2011 paper and work chronologically; check your solutions against the model answers given in IMAT Past Paper Worked Solutions. – these are a final boost to your preparation.



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As you've probably realised by now, there are well over 3,000 questions to tackle meaning that this isn't a test that you can prepare for in a single week. From our experience, the best students will prepare anywhere between four to eight weeks (although there are some notable exceptions!).

Remember that the route to a high score is your approach and practice. Don't fall into the trap that "you can't prepare for the IMAT"– this could not be further from the truth. With knowledge of the test, some useful time-saving techniques and plenty of practice you can dramatically boost your score.

Work hard, never give up and do yourself justice. Good luck!

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THE ULTIMATE IMAT GUIDE

THE BASICS

What is the IMAT?

The International Medical Admissions Test (IMAT) is a 100-minute written exam for students who are applying to read medical and veterinary courses at competitive universities across the world.

What does the IMAT consist of?

Section	SKILLS TESTED	Questions	Timing
ONE	Problem-solving skills, including numerical and spatial reasoning. Critical thinking skills, including understanding arguments and reasoning using everyday language. General knowledge.	22 MCQs	35 minutes
TWO THREE FOUR	Ability to recall, understand and apply scientific knowledge and principles of biology, chemistry, physics, and maths. Usually the section that students find the hardest.	38 MCQs	65 minutes

Why is the IMAT used?

Medical and Dentistry applicants tend to be a bright bunch and therefore usually have excellent grades. This means that competition is fierce – meaning that the universities must use the IMAT to help differentiate between applicants.

When do I sit IMAT?

There is one sitting for the IMAT – it has consistently been the second week of September for the last few years, but do check this. However, registration for the exam opens several months earlier at the start of July and remains open for three weeks. As there is only one sitting of the IMAT per year it is very important that you do not miss the registration deadline for your year of application.

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When should I sit the IMAT?

Unfortunately, you have very little choice in this decision since the sitting of the exam is a fixed date, and your university application will only be considered if it has an accompanying IMAT result sat in the same academic year. The best solution to meet the demands of the exam is to start your preparation early and try to stay up to date with the rules and procedures found on the official IMAT website and at MEDschool.it.

Do I have to resit the IMAT if I reapply?

You only need to resit the IMAT if you are applying to a university that requires it. However, you cannot use your score from any previous attempts.

Where do I sit the IMAT?

For the September sitting, you will need to register yourself and sit the test at one of the authorised centres or participating universities in Italy.

Who has to sit the IMAT?

Applicants to the following universities must sit the IMAT:

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University	Course
University of Bari	Medicine and Surgery degree (English taught)
University of Bologna	Medicine and Surgery degree (English taught)
University of Campania 'Luigi Vanvitelli'	Medicine and Surgery degree (English taught)
University of Milan	Medicine and Surgery degree (English taught)
University of Milan-Bicocca	Medicine and Surgery degree (English taught)
University of Naples Federico II	Medicine and Surgery degree (English taught)
University of Pavia	Medicine and Surgery degree (English taught)
University of Rome 'Sapienza'	Medicine and Surgery degree (English taught)
University of Rome 'Tor Vergata'	Medicine and Surgery degree (English taught)
University of Siena	Dentistry (English taught)
University of Turin	Medicine and Surgery degree (English taught)

How is the IMAT Scored?

In the IMAT all sections are marked the same, and each question carries equal weighting. Remember though that this exam adopts negative marking for each incorrect answer. As such your total score will be calculated using the following method:

- **1.5 points** for a **correct** answer
- **-0.4 points** for a **wrong** answer
- **0 points** for an **unanswered** question

After all the points are added up for each question your result is reported as a total score, along with a breakdown of what you scored in each section.
All candidates are ranked by their score with the rankings published on *accessoprogrammato.miur.it*

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Can I resit the IMAT?

Yes, you can resit the IMAT if you apply for medicine again in the future.

When do I get my results?

For the September sitting, you will get your results by the end of September online. You are then responsible for informing the University of your Score. For the November sitting, The IMAT results are usually released to universities in mid-late November and then to students in late November.

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GENERAL ADVICE

Start Early

It is much easier to prepare if you practice little and often. Start your preparation well in advance, ideally by mid-July but at the latest by early August. This way you will have plenty of time to complete as many papers as you wish to feel comfortable and won't have to panic and cram just before the test, which is a much less effective and more stressful way to learn. In general, an early start will give you the opportunity to identify the complex issues and work at your own pace.

Prioritise

Some questions can be long and complex; however, you get 1.5 points no matter how tough the question – and given the intense time pressure you need to know your limits. It is essential that you don't get stuck with very difficult questions. If a question looks particularly long or complex, mark it for review and move on. You don't want to be caught 5 questions short at the end just because you took more than 3 minutes in answering a challenging multi-step physics question. If a question is taking too long, decide to leave it till the end and move on. Remember that each question carries equal weighting and therefore, you should adjust your timing in accordingly. With practice and discipline, you can get very good at this and learn to maximise your efficiency.

Negative Marking

There is a penalty of -0.4 points for each incorrect answer in the IMAT. This removes the luxury of always being able to guess should you absolutely be not able to figure out the right answer for a question or run behind time. However, this does not mean that you should not guess at all. Since each question provides you with 5 possible answers, you have a 20% chance of guessing correctly. Therefore, if you aren't sure (and are running short of time), try to eliminate a couple of answers to increase your chances of getting the question correct. For example, if a question has 5 options and you manage to eliminate 2 options – your chances of getting the question increase from 20% to 33%!

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Practice

This is the best way of familiarising yourself with the style of questions and the timing for this section. Although the IMAT tests only school science and mathematics, you are unlikely to be familiar with the style of questions in all 4 sections when you first encounter them. Practising questions will put you at ease and make you more comfortable with the exam. The more comfortable you are, the less you will panic on the test day and the more likely you are to score highly. Initially, work through the questions at your own pace, and spend time carefully reading the questions and looking at any additional data. When it becomes closer to the test, **make sure you practice the questions under exam conditions**. This means following the strict time limits, and without a calculator or table of elements.

Extra Practice

If you're blessed with a good memory, you might remember the answers to certain questions in the past papers – making it less useful to repeat them again. If you want to tackle practice questions which are fully up to date, then check out **www.imatschool.com**.

Repeat Questions

When checking through answers, pay particular attention to questions you have got wrong. If there is a worked answer, look through that carefully until you feel confident that you understand the reasoning, and then repeat the question without help to check that you can do it. If only the answer is given, have another look at the question and try to work out why that answer is correct. This is the best way to learn from your mistakes, and means you are less likely to make similar mistakes when it comes to the test. The same applies for questions which you were unsure of and made an educated guess which was correct, even if you got it right. When working through this book, **make sure you highlight any questions you are unsure of**, this means you know to spend more time looking over them once marked.

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No Calculators

You aren't permitted to use calculators in the IMAT – thus, it is essential that you have strong numerical skills. For instance, you should be able to rapidly convert between percentages, decimals and fractions. You will seldom get questions that would require calculators, but you would be expected to be able to arrive at a sensible estimate. Consider for example:

Estimate 3.962 x 2.322

3.962 is approximately 4 and 2.323 is approximately 2.33 = 7/3.

Thus, $3.962 \times 2.322 \approx 4 \times \frac{7}{3} = \frac{28}{3} = 9.33$

Since you will rarely be asked to perform difficult calculations, you can use this as a signpost of if you are tackling a question correctly. For example, when solving a physics question, if you end up having to divide 8,079 by 357, this should raise alarm bells as calculations in the IMAT are rarely this difficult.

Top tip! In general, students tend to improve the fastest in section 2 and slowest in section 1; section 3 usually falls somewhere in the middle. Thus, if you have very little time left, it's best to prioritise section 2.

Manage your Time:

It is highly likely that you will be juggling your revision alongside your normal school studies. Whilst it is tempting to put your A-levels on the back burner, falling behind in your school subjects is not a good idea. Don't forget that to meet the conditions of your offer should you get one you will need at least one A*. So, time management is key!

Make sure you set aside a dedicated 90 minutes (and much closer to the exam) to commit to your revision each day. The key here is not to sacrifice too many of your extracurricular activities – everybody needs some down time – but instead to be efficient. Take a look at our list of top tips for increasing revision efficiency below:

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1. Create a comfortable and tidy work environment
2. See if music works for you. If not, find somewhere peaceful and quiet to work
3. Turn off your mobile or at least put it into silent mode, and keep the TV off and out of sight
4. Stay organised with to do lists and revision timetables – more importantly, stick to them!
5. Adopt a positive mental attitude
6. Consider forming a study group to focus on the harder exam concepts
7. Plan rest and reward days into your timetable

Keep Fit & Eat Well:

'A car won't work if you fill it with the wrong fuel' – your body is exactly the same. You cannot hope to perform unless you remain fit and well. The best way to do this is to not underestimate the importance of healthy eating. Beige, starchy foods will make you sluggish; instead start the day with a hearty breakfast like porridge. Aim for the recommended 'five a day' intake of fruit/veg and stock up on the oily fish or blueberries – the so called "super foods".

When hitting the books, it's essential to keep your brain hydrated. If you get dehydrated, you'll find yourself lethargic and possibly developing a headache, neither of which will do any favours for your revision. Invest in a good water bottle that you know the total volume of and keep sipping through the day. Don't forget that the amount of water you should be aiming to drink varies depending on your mass, so calculate your own personal recommended intake as follows: 30 ml per kg per day.

It is well known that exercise boosts your wellbeing and instils a sense of discipline. It's well worth devoting half an hour a day to some exercise, get your heart rate up, break a sweat, and get those endorphins flowing.

Sleep

It's no secret that when revising you need to keep well rested. Don't be tempted to stay up late revising, as sleep actually plays an important part in consolidating long term memory. Instead, aim for a minimum of 7 hours good sleep each night, in a dark room without any glow from electronic appliances. Install flux (https://justgetflux.com) on your laptop to prevent your computer from disrupting your circadian rhythm. Aim to go to bed the same time each night and no hitting snooze on the alarm clock in the morning!

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A word on timing...

"If you had all day to do your IMAT, you would get 100%. But you don't."

Whilst this isn't completely true, it illustrates a very important point. Once you've practiced and know how to answer the questions, the clock is your biggest enemy. This seemingly obvious statement has one very important consequence: **One of the best ways to improve your IMAT score is to improve your speed.** There is no magic bullet. But there are a great number of techniques that, with practice, will give you significant time gains, allowing you to answer more questions and score more marks.

Timing is tight throughout the IMAT – **mastering timing is the first key to success**. Some candidates choose to work as quickly as possible to save up time at the end to check back, but this is generally not the best way to do it. IMAT questions can have a lot of information in them – each time you start answering a question it takes time to get familiar with the instructions and information. By splitting the question into two sessions (the first run-through and the return-to-check) you double the amount of time you spend on familiarising yourself with the data, as you have to do it twice instead of only once. This costs valuable time. In addition, candidates who do check back may spend 2–3 minutes doing so and yet not make any actual changes. Whilst this can be reassuring, it is a false reassurance as it is unlikely to have a significant effect on your actual score. Therefore, it is usually best to pace yourself very steadily, aiming to spend the same amount of time on each question and finish the final question in a section just as time runs out. This reduces the time spent on re-familiarising with questions and maximises the time spent on the first attempt, gaining more marks.

It is essential that you don't get stuck with the hardest questions – no doubt there will be some. In the time spent answering only one of these you may miss out on answering three easier questions. If a question is taking too long, move on. Never see this as giving up or in any way failing, rather it is the smart way to approach a test with a tight time limit. With practice and discipline, you can get very good at this and learn to maximise your efficiency. It is not about being a hero and aiming for full marks – this is almost impossible and very much unnecessary. It is about maximising your efficiency and gaining the maximum possible number of marks within the time you have.

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Top tip! Ensure that you take a watch that can show you the time in seconds into the exam. This will allow you to have a much more accurate idea of the time you're spending on a question. In general, if you've spent >150 seconds on a section 1 question or >90 seconds on a science question – move on regardless of how close you think you are to solving it.

Use the Options:

Some questions may try to overload you with information. When presented with large tables and data, it's essential you look at the answer options so you can focus your mind. This can allow you to reach the correct answer a lot more quickly. Consider the example below:

The table to the right shows the results of a study investigating antibiotic resistance in staphylococcus populations. A single staphylococcus bacterium is chosen at random from a similar population. Resistance to any one antibiotic is independent of resistance to others.

Antibiotic	Number of Bacteria tested	Number of Resistant Bacteria
Benzyl-penicillin	10^{11}	98
Chloramphenicol	10^{9}	1200
Metronidazole	10^{8}	256
Erythromycin	10^{5}	2

Calculate the probability that the bacterium selected will be resistant to all four drugs.

A 1 in 10^{6}
B 1 in 10^{12}
C 1 in 10^{20}
D 1 in 10^{25}
E 1 in 10^{30}
F 1 in 10^{35}

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Looking at the options first makes it obvious that there is **no need to calculate exact values** – only in powers of 10. This makes your life a lot easier. If you hadn't noticed this, you might have spent well over 90 seconds trying to calculate the exact value when it wasn't even being asked for. In other cases, you may actually be able to use the options to arrive at the solution quicker than if you had tried to solve the question as you normally would.

Consider the example below:
A region is defined by the two inequalities: $x - y^2 > 1$ and $xy > 1$. Which of the following points is in the defined region?

A. (10, 3)
B. (10, 2)
C. (-10, 3)
D. (-10, 2)
E. (-10, -3)

Whilst it's possible to solve this question both algebraically and graphically by manipulating the identities, by far **the quickest way is to actually use the options**. Note that options **C**, **D** and **E** violate the second inequality, narrowing down to answer to either **A** or **B**. For **A**: $10 - 3^2 = 1$ and so this point is on the boundary of the defined region and not actually in the region. Thus, the answer is **B** (as $10 - 4 = 6 > 1$.)

In general, it pays dividends to look at the options briefly and see if they can be help you arrive at the question more quickly. Get into this habit early – it may feel unnatural at first, but it's guaranteed to save you time in the long run.

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Keywords

If you're stuck on a question; pay particular attention to the options that contain key modifiers like "**always**", "**only**", or "**all**" as examiners like using them to test if there are any gaps in your knowledge. E.g., the statement "arteries carry oxygenated blood" would normally be true; "All arteries carry oxygenated blood" would be false because the pulmonary artery carries deoxygenated blood.

Revision Timetable

Still struggling to get organised? Then try filling in the revision timetable on the next page. Remember to schedule in several breaks throughout the day and actually use them to do something you enjoy.

	8AM	10AM	12PM	2PM	4PM	6PM
MONDAY						
TUESDAY						
WEDNESDAY						
THURSDAY						

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FRIDAY						
SATURDAY						
SUNDAY						

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SECTION 1

This is the first section of the IMAT and as you walk in, it is inevitable that you will feel nervous. Make sure that you have been to the toilet because once it starts you cannot simply pause and go. Take a few deep breaths and calm yourself down. Remember that panicking will not help and may negatively affect your marks – so try and avoid this as much as possible.

You have 35 minutes to answer 22 questions in section 1. The questions fall into four categories:

- Problem solving
- Data handling
- Critical thinking
- General knowledge

Whilst this section of the IMAT is renowned for being difficult to prepare for, there are powerful shortcuts and techniques that you can use to save valuable time on these types of questions.
You have approximately 100 seconds per question; this may sound like a lot but given that you're often required to read and analyse passages or graphs- it can often not be enough. Nevertheless, this section is not as time pressured as section 2 so most students usually finish the majority of questions in time. However, some questions in this section are very tricky and can be a big drain on your time. **People who fail to complete section 1 are those who get bogged down on a particular question**.

Therefore, it is vital that you start to get a feel for which questions are going to be easy and quick to do, and which ones should be left till the end. The best way to do this is through practice and the questions in this book will offer extensive opportunities for you to do so.

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SECTION 1: GENERAL KNOWLEDGE

The last questions in section 1 are based on your general knowledge. This book does not have a chapter dedicated to this as there is no real technique to answering these questions – you either know the answer or you do not. In 2018 and the years before, there were usually only two general knowledge questions. However, in 2019 and 2020, section 1 in both papers had 12 general knowledge questions. This is a significant number, so it is worth revising in case the pattern continues. Practice general knowledge questions are available in the IMAT past papers and in the mock papers in the final section of this book.

In terms of the subject matter, the knowledge required is nothing too niche or in-depth. However, remember that the exam is for entrance into Italian medical schools, so don't fall into the trap of only learning facts about your home country. Though it is impossible to predict what will come up, the following list is a good guide:

- World geography – you should know the rough location of every country.
- Currencies of the world – at least learn which countries in Europe do not use the Euro.
- Significant historical events and figures
- Nobel prize winners
- International political organisations – NATO, the UN etc
- Famous artists, musicians, and writers (including Dante Alighieri and other famous Italians)
- A basic understanding of the Italian political system

The best way to get a feel for what you need to learn, and importantly what you already know, is simply to attempt all the papers you can once you have finished practicing the other, more complex, question types. A fun and effective way to revise, instead of making flashcards or trawling through textbooks, would be to simply find your favourite trivia apps, websites, or books (as long as they are not too pop-culture oriented) and challenge yourself to do 10 minutes a day.

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SECTION 1: CRITICAL THINKING

IMAT Critical thinking questions require you to understand the constituents of a good argument and be able to pick them apart. The majority of IMAT Critical thinking questions tend to fall into 3 major categories:

1. Identifying Conclusions
2. Identifying Assumptions + Flaws
3. Strengthening and Weakening arguments

Having a good grasp of language and being able to filter unnecessary information quickly and efficiently is a vital skill in medical school – you simply do not have the time to sit and read vast numbers of textbooks cover to cover, you need to be able to filter the information and realise which part is important – this will contribute to success in your studies. Similarly, when you have qualified and are on the wards, you need to be able to pick out key information from patient notes and make healthcare decisions from them, so getting to grips with verbal reasoning goes a long way. Do not underestimate its importance.

Top tip! Though it might initially sound counter-intuitive, it is often best to read the question ***before*** reading the passage. Then you'll have a much better idea of what you're looking for and are therefore more likely to find it quicker.

Only use the Passage

Your answer must only be based on the information available in the passage. Do not try and guess the answer based on your general knowledge as this can be a trap. For example, if the passage says that spring is followed by winter, then take this as true even though you know that spring is followed by summer.

Take your time

Unlike the problem-solving questions, critical thinking questions are less time pressured. Most of the passages are well below 300 words and therefore don't take long to read and process. Thus, your aim should be to understand the intricacies of the passage and identify key information so that you don't miss key information and lose easy marks.

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Identifying Conclusions

Students struggle with these types of questions because they confuse a premise for a conclusion. For clarity's sake:

- A **Conclusion** is a summary of the arguments being made and is usually explicitly stated or heavily implied.
- A **Premise** is a statement from which another statement can be inferred or follows as a conclusion.

Hence a conclusion is shown, implied or proven by a premise. Similarly, a premise shows, indicates or establishes a conclusion. Consider for example: *My mom, being a woman, is clever as all women are clever.*

Premise 1: My mom is a woman + **Premise 2:** Women are clever = **Conclusion:** My mom is clever.

This is fairly straightforward as it's a very short passage and the conclusion is explicitly stated. Sometimes the latter may not happen.

Consider: *My mom is a woman and all women are clever.* Here, whilst the conclusion is not explicitly being stated, both premises still stand and can be used to reach the same conclusion.

You may sometimes be asked to identify if any of the options cannot be "reliably concluded". This is effectively asking you to identify why an option **cannot** be the conclusion. There are many reasons why, but the most common ones are:

1. Over-generalising: *My mom is clever therefore all women are clever.*
2. Being too specific: All kids like candy so my son also likes candy.
3. Confusing correlation vs. causation: *Lung cancer is much more likely in patients who drink water. Hence, water causes lung cancer.*
4. Confusing cause and effect: *Lung cancer patients tend to smoke so it follows that having lung cancer must make people want to smoke.*

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Note how conjunctives like hence, thus, so, therefore and it follows give you a clue as to when a conclusion is being stated. More examples of these include: "it follows that, implies that, whence, entails that". Similarly, words and phrases like "because", "as indicated by", "in that", "given that" and "due to the fact that" usually identify premises.

Assumptions + Flaws:

Other types of critical thinking questions may require you to identify assumptions and flaws in a passage's reasoning. Before proceeding it is useful to define both:

- An assumption is a reasonable assertion that can be made on the basis of the available evidence.
- A flaw is an element of an argument which is inconsistent to the rest of the available evidence. It undermines the crucial components of the overall argument being made.

Consider for example: *My mom is clever because all doctors are clever.*
Premise 1: Doctors are clever. **Assumption:** My mom is a doctor. **Conclusion:** My mom is clever.

Note that the conclusion follows naturally even though there is only one premise because of the assumption. The argument relies on the assumption to work. Thus, if you are unsure if an option you have is an assumption or not, just ask yourself:

1) *Is it in the passage?* If the answer is **no,** then proceed to ask:
2) *Does the conclusion rely on this piece of information in order to work?* – If the answer is **yes** – then you've identified an assumption.

You may sometimes be asked to identify flaws in an argument – it is important to be aware of the types of flaws to look out for. In general, these are broadly similar to the ones discussed earlier in the conclusion section (over-generalising, being too specific, confusing cause and effect, confusing correlation and causation). Remember that an assumption may also be a flaw.

For example, consider again: *My mom is clever because all doctors are clever.*
What if the mother was not actually a doctor? The argument would then breakdown as the assumption would be incorrect or **flawed**.

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Top tip! Don't get confused between premises and assumptions. A **premise** is a statement that is explicitly stated in the passage. An **assumption** is an inference that is made from the passage.

Strengthening and Weakening Arguments:

You may be asked to identify an answer option that would most strengthen or weaken the argument being made in the passage. Normally, you'll also be told to assume that each answer option is true. Before we can discuss how to strengthen and weaken arguments, it is important to understand what constitutes a good argument:

1. **Evidence:** Arguments which are heavily based on value judgements and subjective statements tend to be weaker than those based on facts, statistics, and the available evidence.
2. **Logic**: A good argument should flow, and the constituent parts should fit well into an overriding view or belief.
3. **Balance:** A good argument must concede that there are other views or beliefs (counterargument). The key is to carefully dismantle these ideas and explain why they are wrong.

Thus, when asked to strengthen an argument, look for options that would: increase the evidence basis for the argument, support or add a premise, or address the counterarguments.
Similarly, when asked to weaken an argument, look for options that would: decrease the evidence basis for the argument or create doubt over existing evidence, undermine a premise, or strengthen the counterarguments.

In order to be able to strengthen or weaken arguments, you must completely understand the passage's conclusion. Then you can start testing the impact of each answer option on the conclusion to see which one strengthens or weakens it the most, i.e. is the conclusion stronger/weaker if I assume this information to be true and included in the passage.

Often, you'll have to decide which option strengthens/weakens the passage most – and there really isn't an easy way to do this apart from lots of practice. Thankfully, you have plenty of time for these questions.

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CRITICAL THINKING QUESTIONS

Question 1-6 are based on the passage below:

People have tried to elucidate the differences between the different genders for many years. Are they societal pressures or genetic differences? In the past it has always been assumed that it was programmed into our DNA to act in a certain more masculine or feminine way but now evidence has emerged that may show it is not our genetics that determines the way we act, but that society pre-programmes us into gender identification. Whilst it is generally acknowledged that not all boys and girls are the same, why is it that most young boys like to play with trucks and diggers whilst young girls prefer dollies and pink?

The society we live in has always been an important factor in our identity. Take cultural differences: the language we speak the food we eat, the clothes we wear. All these factors influence our identity. New research finds that the people around us may prove to be the biggest influence on our gender behaviour. It shows our parents buying gendered toys may have a much bigger influence than the genes they gave us. Girls are being programmed to like the same things as their mothers and this has lasting effects on their personality. Young girls and boys are forced into their gender stereotypes through the clothes they are bought, the hairstyle they wear and the toys they play with.

The power of society to influence gender behaviour explains the cases where children have been born with different external sex organs to those that would match their sex determining chromosomes. Despite the influence of their DNA, they identify with the gender they have always been told they are. Once the difference has been detected, how are they then ever to feel comfortable in their own skin? The only way to prevent society having such a large influence on gender identity is to allow children to express themselves, wear what they want and play how they want without fear of not fitting in.

Question 1:

What is the main conclusion from the first paragraph?

A. Society controls gender behaviour.
B. People are different based on their gender.
C. DNA programmes how we act.
D. Boys do not like the same things as girls because of their genes.
E. Genetics may not have as big an influence as assumed.

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Question 2:

Which of the following, if true, points out the flaw in the first paragraph's argument?

A. Not all boys like trucks.
B. Genes control the production of hormones.
C. Differences in gender may be due to an equal combination of society and genes.
D. Hormonal and environmental factors may also have a large contribution to behaviour.
E. Some girls like trucks.

Question 3:

According to the statement, how can culture affect identity?

A. Culture can influence what we wear and how we speak.
B. Our parents act the way they do because of culture.
C. Culture affects our genetics.
D. Culture usually relates to where we live.
E. Clothes, hairstyles and toys have a big impact on identity.

Question 4:

Which of these is most implied by the statement?

A. Gender identity is quite fluid.
B. Children are programmed to like the things they do by their DNA.
C. Girls like dollies and pink because their mothers do.
D. It is wrong for boys to have long hair like girls.
E. Children usually identify with the gender they appear to be.

Question 5:

What does the statement say is the best way to prevent gender stereotyping?

A. Mothers spending more time with their sons.
B. Parents buying gender-neutral clothes for their children.
C. Allowing children to act how they want.
D. Not telling children if they have different sex organs.
E. Making children wear all different types of clothes.

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Question 6:
What, according to the statement is the biggest problem for children born with different external sex organs to those which match their sex chromosomes?

A. They may have other problems with their DNA.
B. Society may not accept them for who they are.
C. They may wish to be another gender.
D. They are not the gender they are treated as which can be distressing.
E. Children with different external sex organs may have gender identity disorders

Questions 7-11 are based on the passage below:
New evidence has emerged that the most important factor in a child's development could be their napping routine. It has come to light that regular napping could well be the deciding factor for determining toddlers' memory and learning abilities. The new countrywide survey of 1000 toddlers, all born in the same year showed around 75% had regular 30-minute naps. Parents cited the benefits of their child having a regular routine (including mealtimes), such as decreased irritability, and stated the only downfall of occasional problems with sleeping at night. Research indicating that toddlers were 10% more likely to suffer regular night-time sleeping disturbances when they regularly napped supported the parent's view.

Those who regularly took 30-minute naps were more than twice as likely to remember simple words such as those of new toys than their non-napping counterparts, who also had higher incidences of memory impairment, behavioural problems and learning difficulties. Toddlers who regularly had 30-minute naps were tested on whether they were able recall the names of new objects the following day, compared to a control group who did not regularly nap. These potential links between napping and memory, behaviour and learning ability provides exciting new evidence in the field of child development.

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Question 7:

If there are 100 toddlers, 5% of who did not nap and were able to remember a new teddy's name, how many who had napped would be expected to remember?

A. 5
B. 6
C. 8
D. 10
E. 12

Question 8:

Which of these is most implied by the statement?

A. Regular napping has many benefits for toddlers
B. All toddlers who nap have better memories than toddlers who do not
C. Parents of toddlers who nap are happier than parents of toddlers who do not
D. Regular napping as a toddler means they will have a better memory as an adult
E. All toddlers should nap every day

Question 9:

Using the information from the passage above, which of the following is the most plausible alternative reason for the link between memory and napping?

A. Children who nap are more interested in the studies being performed.
B. Children who regularly nap, are born with better memories.
C. Children who do not nap were unable to concentrate on the memory testing exercises for the study.
D. Parents who enforce a routine of napping are more likely to conduct memory exercises with their children.
E. Children who have bad memory abilities are likely to have trouble sleeping.

Question 10:

Which of the following is most strongly indicated?

A. Families have more enjoyable mealtimes when their toddlers regularly nap.
B. Toddlers have better routines when they nap.
C. Parents enforce napping to improve their toddlers' memory ability.
D. Napping is important for parents' routines.
E. Routines are the most important thing for memory development.

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Question 11:

Which of the following, if true, would strengthen the conclusion that there is a causal link between regular napping and improved memory in toddlers?

A. Improved memory is also associated with regular mealtimes.
B. Parents who enforce regular napping are more inclined to include their children in studies.
C. Toddlers' memory development is so rapid that even a few weeks can make a difference to performance.
D. Among toddler playgroups where the napping is more frequent and more consistent, memory is significantly improved compared to playgroups where napping is less frequent and consistent
E. Later in life, children who did not nap perform worse in examinations.

Question 12:

Tom's father says to him: 'You must work for your A-levels. That is the best way to do well in your A-level exams. If you work especially hard for Geography, you will definitely succeed in your Geography A-level exam'.

Which of the following is the best statement Tom could say to prove a flaw in his father's argument?

A. "It takes me longer to study for my history exam, so I should prioritise that."
B. "I do not have to work hard to do well in my Geography A-level."
C. "Just because I work hard, does not mean I will do well in my A-levels."
D. "You are putting too much importance on studying for A-levels."
E. "You haven't accounted for the fact that Geography is harder than my other subjects."

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Question 13:
Today the NHS is increasingly struggling to be financially viable. In the future, the NHS may have to reduce the services it cannot afford. The NHS is supported by government funds, which come from those who pay tax in the UK. Recently the NHS has been criticised for allowing fertility treatments to be free, as many people believe these are not important and should not be paid for when there is not enough money to pay the doctors and nurses.

Which of the following is the most accurate conclusion of the statement above?
A. Only taxpayers should decide where the NHS spends its money.
B. Doctors and nurses should be better paid.
C. The NHS should stop free fertility treatments.
D. Fertility treatments may have to be cut if finances do not improve.
E. The public think fertility treatments are pointless.

Question 14:
We should allow people to drive as fast as they want. By allowing drivers to drive at fast speeds, through natural selection the most dangerous drivers will kill only themselves in car accidents. These people will not have children, hence only safe people will reproduce and eventually the population will only consist of safe drivers.

Which one of the following, if true, most weakens the above argument?
A. Dangerous drivers harm others more often than themselves by driving too fast.
B. Dangerous drivers may produce children who are safe drivers.
C. The process of natural selection takes a long time.
D. Some drivers break speed limits anyway.
E. Slow driving can be as dangerous as fast driving.

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Question 15:

In the winter of 2014, the UK suffered record levels of rainfall which led to catastrophic damage across the country. Thousands of homes were damaged and even destroyed, leaving many homeless in the chaos that followed. The Government faced harsh criticism that they had failed to adequately prepare the country for the extreme weather. In such cases, the Government assesses the likelihood of such events happening in the future and balance against the cost of advance measures to reduce the impact should they occur versus the cost of the event with no preparative defences in place. Until recently, for example, the risk of acts of terror taking was low compared with the vast cost anticipated should they occur. However, the risk of flooding is usually low, so it could be argued that the costs associated with anti-flooding measures would have been pre-emptively unreasonable. Should the Government be expected to prepare for every conceivable threat that could come to pass? Are we to put in place expensive measures against a seismic event as well as a possible extra-terrestrial invasion?

Which of the following best expresses the main conclusion of the statement above?

A. The Government has an obligation to assess risks and costs of possible future events.
B. The Government should spend money to protect against potential extra-terrestrial invasions and seismic events.
C. The Government should have spent money to protect against potential floods.
D. The Government was justified in not spending heavily to protect against flooding.
E. The Government should assist people who lost their homes in the floods.

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Question 16:

Sadly, the way in which children interact with each other has changed over the years. Where once children used to play sports and games together in the street, they now sit alone in their rooms on the computer playing games on the Internet. In the past young children learned human interaction from active games with their friends – this is no longer the case. How then, when these children are grown up, will they be able to socially interact with their colleagues?

Which one of the following is the conclusion of the above statement?

A. Children growing up in the modern world may experience difficulties in social interaction later on in life.
B. The Internet can be a tool for teaching social skills.
C. Computer games are for social development.
D. Children should be made to play outside with their friends to develop their social skills for later in life.
E. Adults will in the future play computer games as a means of interaction.

Question 17:

Between 2006 and 2013 the British government spent £473 million on Tamiflu antiviral drugs in preparation for a flu pandemic, despite there being little evidence to support the effectiveness of the drug. The antivirals were stockpiled for a flu pandemic that never fully materialised. Only 150,000 packs were used during the swine flu episode in 2009, and it is unclear if this improved outcomes. Therefore, this money could have been much better spent on drugs that would actually benefit patients.

Which option best summarises the author's view in the passage?

A. Drugs should never be stockpiled, as they may not be used.
B. Spending millions of pounds on drugs should be justified by evidence showing positive effects.
C. We should not prepare for flu pandemics in the future.
D. The recipients of Tamiflu in the swine flu pandemic had no difference in symptoms or outcomes to patients who did not receive the antivirals.
E. We should not use drugs which don't have a good body of evidence to back them up.

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Question 18:

High BMI, and particularly central weight, are risk factors associated with increased morbidity and mortality. Many believe the development of cheap, easily accessible fast-food outlets is partly responsible for the increase in rates of obesity. An unhealthy weight is commonly associated with a generally unhealthy lifestyle, such a lack of exercise. The best way to tackle the growing problem of obesity is for the government to tax unhealthy foods so they are no longer a cheap alternative.

Why is the solution given, to tax unhealthy foods, not a logical conclusion from the passage?

A. Unhealthy eating is not exclusively confined to low-income families.
B. A more general approach to unhealthy lifestyles would be optimal.
C. People do not only choose to eat unhealthy food because it is cheaper.
D. People need to take personal responsibility for their own health.
E. It does not matter what people are eating as long as they exercise too.

Question 19:

As people are living longer, care in old age is becoming a larger burden. Many people require carers to come into their home numerous times a day or need full residential care. It is not right that the NHS should be spending vast funds on the care of people who are sufficiently wealthy to fund their own care. Some argue that they want their savings kept to be given to their children; however this is not a right, simply a luxury. It is not right that people should be saving and depriving themselves of necessary care, or worse, making the NHS pay the bill, so they have money to pass on to their offspring. People need to realise that there is a financial cost to living longer.

Which of the following statements is the main conclusion of the above passage?

A. We need to take a personal responsibility for our care in old age.
B. Caring for the elderly is a significant burden on the NHS.
C. The reason people are reluctant to pay for their own care is that they want to pass money onto their offspring.
D. The NHS should limit care to the elderly to reduce their costs.
E. People shouldn't save their money for old age.

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Question 20:

There is much interest in research surrounding production of human stem cells from non-embryo sources for potential regenerative medicine, and a huge financial and personal gain at stake. In January 2014, a team from Japan published two papers in Nature that claimed to have developed totipotent stem cells from adult mouse cells by exposure to an acidic environment. However, there has since been much controversy surrounding these papers. Problems included: inability by other teams to replicate the results of the experiment, an insufficient protocol described in the paper and issues with images in one of the papers. It was dishonest of the researchers to publish the papers with such problems, and a requirement of a paper is a sufficiently detailed protocol, so that another group could replicate the experiment.

Which statement is most implied?

A. Research is fuelled mainly by financial and personal gains.
B. If it cannot be replicated it is not good scientific practice.
C. Rivalry between different research groups makes premature publishing more likely.
D. The discrepancies were in only one of the papers published in January 2014.
E. The researchers should take responsibility for publishing a paper with such flaws.

Question 21:

The placebo effect is a well-documented medical phenomenon in which a patient's condition undergoes improvement after being given an ineffectual treatment that they believe to be a genuine treatment. It is frequently used as a control during trials of new drugs/procedures, with the effect of the drug being compared to the effect of a placebo, and if the drug does not have a greater effect than the placebo, then it is classed as ineffective. However, this analysis discounts the fact that the drug treatment still has more of a positive effect than no action, and so we are clearly missing out on the potential to improve certain patient conditions. It follows that where there is a demonstrated placebo effect, but treatments are ineffective, we should still give treatments, as there will therefore be some benefit to the patient.

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Which of the following best expresses the main conclusion of this passage?

A. In situations where drugs are no more effective than a placebo, we should still give drugs, as they will be more effective than not taking action.
B. Our current analysis discounts the fact that even if drug treatments have no more effect than a placebo, they may still be more effective than no action.
C. The placebo effect is a well-recognised medical phenomenon.
D. Drug treatments may have negative side effects that outweigh their benefit to patients.
E. Placebos are better than modern drugs.

Question 22:

The speed limit on motorways and dual carriageways has been 70mph since 1965, but this is an out-dated policy and needs to change. Since 1965, car brakes have become much more effective, and many safety features have been introduced into cars, such as seatbelts (which are now compulsory to wear), crumple zones and airbags. Therefore, it is clear that cars no longer need to be restricted to 70mph, and the speed limit can be safely increased to 80mph without causing more road fatalities.

Which of the following best illustrates an assumption in this passage?

A. The government should increase the speed limit to 80mph.
B. If the speed limit were increased to 80mph, drivers would not begin to drive at 90mph.
C. The safety systems introduced reduce the chances of fatal road accidents for cars travelling at higher speeds.
D. The roads have not become busier since the 70mph speed limit was introduced.
E. The public want the speed limit to increase.

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Question 23:

High levels of alcohol consumption are proven to increase the risk of many non-infectious diseases, such as cancer, atherosclerosis, and liver failure. James is a PhD student, and is analysing the data from a large-scale study of over 500,000 people to further investigate the link between heavy alcohol consumption and health problems. In the study, participants were asked about their alcohol consumption, and then their medical history was recorded. His analysis displays surprising results, concluding that those with high alcohol consumption have a *decreased* risk of cancer. James decides that those carrying out the study must have incorrectly recorded the data.

Which of the following is **NOT** a potential reason why the study has produced these surprising results?

A. Previous studies were incorrect, and high alcohol consumption does lower the risk of cancer.
B. The studies didn't take account other cancer risk factors in comparing those with high and low alcohol consumption.
C. James has made some errors in his analysis, and thus his conclusions are erroneous.
D. The participants involved in the study did not truthfully report their alcohol consumption, leading to false conclusions being drawn.
E. The study's control group data was mixed up with the test group data.

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Question 24:

Despite the overwhelming scientific proof of the theory of evolution, and even acceptance of the theory by many high-ranking religious ministers, there are still sections of many major religions that do not accept evolution as true. One of the most prominent of these in western society is the Intelligent Design movement, which promotes the religious-based (and scientifically discredited) notion of Intelligent Design as a scientific theory. Intelligent Design proponents often point to complex issues of biology as proof that God is behind the design of human beings, much as a watchmaker is inherent in the design of a watch.

One part of anatomy that has been identified as supposedly supporting Intelligent Design is fingerprints, with some proponents arguing that they are a mark of individualism created by God, with no apparent function except to identify each human being as unique. This is incorrect, as fingerprints do have a well-documented function – namely channelling away of water to improve grip in wet conditions – in which hairless, smooth skinned hands otherwise struggle to grip smooth objects. The individualism of fingerprints is accounted for by the complexity of thousands of small grooves. Development is inherently affected by stochastic or random processes, meaning that the body is unable to uniformly control its development to ensure that fingerprints are the same in each human being. Clearly, the presence of individual fingerprints does nothing to support the so-called-theory of Intelligent Design.

Which of the following best illustrates the main conclusion of this passage?

A. Fingerprints have a well-established function.
B. Evolution is supported by overwhelming scientific proof.
C. Fingerprints do not offer any support to the notion of Intelligent Design.
D. The individual nature of fingerprints is explained by stochastic processes inherent in development that the body cannot uniformly control.
E. Intelligent design is a credible and scientifically rigorous theory.

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Question 25:

A train is scheduled to depart from Newcastle at 3:30pm. It stops at Durham, Darlington, York, Sheffield, Peterborough and Stevenage before arriving at Kings Cross station in London, where the train completes its journey. The total length of the journey between Newcastle and Kings Cross was 230 miles, and the average speed of the train during the journey (including time spent stood still at calling stations) is 115mph. Therefore, the train will complete its journey at 5:30pm.

Which of the following is an assumption made in this passage?

A. The various stopping points did not increase the time taken to complete the journey.
B. The train left Newcastle on time.
C. The train travelled by the most direct route available.
D. The train was due to end its journey at Kings Cross.
E. There were no signalling problems encountered on the journey.

Question 26:

There have been many arguments over the last couple of decades about government expenditure on healthcare in the various devolved regions of the UK. It is often argued that since spending on healthcare per person is higher in Scotland than in England, the people in Scotland will be healthier. However, this view fails to take into account the different needs of these 2 populations in the UK. For example, one major factor is that Scotland gets significantly colder than England, and cold weakens the immune system, leaving people in Scotland at much higher risk of infectious disease. Thus, Scotland requires higher levels of healthcare spending per person simply to maintain the health of the populace at a similar level to that of England.

Which of the following is a conclusion that can be drawn from this passage?

A. The higher healthcare spending per person in Scotland does not necessarily mean people living in Scotland are healthier.
B. Healthcare spending should be increased across the UK.
C. Wales requires more healthcare spending per person simply to maintain population health at a similar level to England.
D. It is unfair on England that there is more spending on healthcare per person in Scotland.
E. Scotland's healthcare budget is a controversial topic.

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Question 27:

Vaccinations have been hugely successful in reducing the incidence of several diseases throughout the 20th century. One of the most spectacular achievements was arguably the global eradication of smallpox, once a deadly worldwide killer, during the 1970s. Fortunately, there was a highly effective vaccine available for smallpox, and a major factor in its eradication was an aggressive vaccination campaign. Another disease that is potentially eradicable is polio. However, although there is a highly effective vaccine for polio available, attempts to eradicate it have so far been unsuccessful. It follows that we should plan and execute an aggressive vaccination campaign for polio, in order to ensure that this disease too is eradicated.

Which of the following is the main conclusion of this passage?

A. Polio is a potentially eradicable disease.
B. An aggressive vaccination campaign was a major factor in the eradication of smallpox.
C. Both polio and smallpox have been eradicated by effective vaccination campaigns.
D. We should execute an aggressive vaccination campaign for polio.
E. The eradication of smallpox remains one of the most spectacular achievements of medical science.

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Question 28:

The Y chromosome is one of 2 sex chromosomes found in the human genome, the other being the X chromosome. As the Y chromosome is only found in males, it can only be passed from father to son. Additionally, the Y chromosome does not exchange sections with other chromosomes (as happens with most chromosomes), meaning it is passed on virtually unchanged through the generations. All of this makes the Y chromosome a fantastic tool for genetic analysis, both to identify individual lineages and to investigate historic population movements. One famous achievement of genetic research using the Y chromosome provides further evidence of its utility, namely the identification of Genghis Khan as an ancestor of up to 8% of males in 16 populations across Asia.

Which of the following best illustrates the main conclusion of this passage?

A. The Y chromosome is a fantastic tool for genetic analysis.
B. Research using the Y chromosome has been able to identify Genghis Khan as the ancestor of up to 8% of men in many Asian populations.
C. The Y chromosome does not exchange sections with other chromosomes.
D. The Y chromosome is a sex chromosome.
E. Genghis Khan had a staggering number of children.

Question 29:

In order for a bacterial infection to be cleared, a patient must be treated with antibiotics. Rachel has a minor lung infection, which is thought by her doctor to be a bacterial infection. She is treated with antibiotics, but her condition does not improve. Therefore, it must not be a bacterial infection.

Which of the following best illustrates a flaw in this reasoning?

A. It assumes that a bacterial infection would definitely improve after treatment with antibiotics.
B. It ignores the other potential issues that could be treated by antibiotics.
C. It assumes that antibiotics are necessary to treat bacterial infections.
D. It ignores the actions of the immune system, which may be sufficient to clear the infection regardless of what has caused it.
E. It assumes that antibiotics are the only option to treat a bacterial infection.

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Question 30:

The link between smoking and lung cancer has been well established for many decades by overwhelming numbers of studies and conclusive research. The answer is clear and simple: the single best measure that can be taken to avoid lung cancer is to not smoke, or to stop smoking if one has already started. However, despite the overwhelming evidence and clear answers, many smokers continue to smoke, and seek to minimise their risk of lung cancer by focusing on other, less important risk factors, such as exercise and healthy eating. This approach is obviously severely flawed, and the fact that some smokers feel this is a good way to reduce their risk of lung cancer shows that they are delusional.

Which of the following best illustrates the main conclusion of this passage?

A. Many smokers ignore the largest risk factor and focus on improving less important risk factors by eating healthily and exercising.
B. Some smokers are delusional.
C. The biggest risk factor of lung cancer is smoking.
D. Overwhelming studies have proven the link between smoking and lung cancer.
E. The government should ban smoking in order to reduce the incidence of lung cancer.

Question 31:

The government should invest more money into outreach schemes in order to encourage more people to go to university. These schemes allow students to meet other people who went to university, which they may not always be able to do otherwise, even on open days.

Which of the following is the best conclusion of the above argument?

A. Outreach schemes are a good way to encourage people to go to university.
B. People will not go to university without seeing it first.
C. The government wants more people to go to university.
D. Meeting people who went to a university is a more effective method than university open days.
E. It is easier to meet people on outreach schemes than on open days.

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Question 32:

The illegal drug cannabis was recently upgraded from a Class C drug to Class B, which means it will be taken less in the UK, because people will know it is more dangerous. It also means if people are caught possessing the drug, they will face a longer prison sentence than before, which will also discourage its use.

Which statement if true, most weakens the above argument?

A. Class C drugs are cheaper than class B drugs.
B. Upgrading drugs in other countries has not reduced their use.
C. People who take illegal drugs do not know what class they are.
D. Cannabis was not the only class C drug before it was upgraded.
E. Even if they are caught possessing class B drugs, people do not think they will go to prison.

Question 33:

Schools with better sports programmes such as well-performing football and netball teams tend to have better academic results, less bullying and have overall happier students. Thus, if we want schools to have the best results, reduce bullying and increase student happiness, teachers should start more sports clubs.

Which one of the following best demonstrates a flaw in the above argument?

A. Teachers may be too busy to start sports clubs.
B. Better academic results may be a precondition of better sports teams.
C. Better sports programmes may prevent students from spending time with their family.
D. Some sports teams may be seen to encourage internal bullying.
E. Sport teams that do not perform well lead to increase bulling.

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Question 34:
The legal age for purchasing alcohol in the UK is 18. This should be lowered to 16 because the majority of 16-year-olds drink alcohol anyway without any fear of repercussions. Even if the police catch a 16-year-old buying alcohol, they are unable to enforce any consequences. If the drinking limit was lowered the police could spend less time trying to catch underage drinkers and deal with other more important crimes. There is no evidence to suggest that drinking alcohol at 16 is any more dangerous than at 18.

Which one of the following, if true, most weakens the above argument?
A. Most 16-year-olds do not drink alcohol.
B. If the legal drinking age were lowered to 16, more 15-year-olds would start purchasing alcohol.
C. Most 16-year-olds do not have enough money to buy alcohol.
D. Most 16-year-olds are able to purchase alcohol currently.
E. You are not old enough to make sensible drinking decisions at 16.

Question 35:
There has been a recent change in the way the government helps small businesses. Whilst previously small businesses were given non-repayable grants to help them grow their profits, they can now only receive government loans that must be repaid with interest when the business turns a certain amount of profit. The government wants to support small businesses, but studies have shown they are less likely to prosper under the new scheme as they have been deterred from taking government money for fear of loan repayments.

Which one of the following can be concluded from the passage above?
A. Small businesses do not want government money.
B. The government cannot afford to give out grants to small businesses anymore.
C. All businesses avoid accumulating debt.
D. The action of the government is more likely to do more harm than good to small businesses.
E. Big businesses do not need government money.

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Questions 36-41 are based on the passage below:

Despite the numerous safety measures in place within the practice of medicine, these can fail when the weaknesses in the layers of defence aligns to create a clear path leading to often disastrous results. This is known as the 'Swiss cheese model of accident causation'. One such occurrence occurred where the wrong kidney was removed from a patient due to a failure in the line of defences designed to prevent such an incident occurring.

When a kidney is diseased it is removed to prevent further complications. This operation, a nephrectomy, is regularly performed by experienced surgeons. Where normally the consultant who knew the patient would have conducted the procedure, in this case he passed the responsibility to his registrar, who was also experienced but had not met the patient previously. The person who had copied out the patient's notes had poor handwriting had accidentally written the 'R' for 'right' in such a way that it was read as an 'L' and subsequently copied, and not noticed by anyone who further reviewed the notes.

The patient had been put asleep before the registrar had arrived and so he proceeded without checking the procedure with the patient, as he normally would have done. The nurses present noticed this error but said nothing, fearing repercussions for questioning a senior professional. A medical student, who had met the patient previously, was present and tried to alert the registrar to the mistake he was about to make. The registrar shouted at the student that she should not interrupt surgery; she did not know what she was talking about and asked her to leave. Consequently, the surgery proceeded with the end result being that the patient's healthy left kidney was removed, leaving them with only their diseased right kidney, which would eventually lead to the patient's unfortunate death. Frightening as these cases appear, what is perhaps scarier is the thought of how those reported may be just the 'tip of the iceberg'.

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When questioned about his action to allow his registrar to perform the surgery alone, the consultant had said that it was normal to allow capable registrars to do this, saying that while the public perception is that medical knowledge steadily increases over time, this is not the case with many doctors who reach their peak in the middle of their careers. He had found that his initial increasing interest in surgery had enhanced his abilities, but with time and practice, the similar surgeries had become less exciting and so his lack of interest had correlated with worsening outcomes, thus justifying his decision to devolve responsibility in this case.

Question 36:

Which of the following, if true, most weakens the argument above?

A. If incidences are severe enough to occur, they will be reported.
B. Doctors undergo extensive training to reduce risks.
C. Thousands of operations happen every year with no problems.
D. Some errors are unavoidable.
E. The patient could have passed away even if the operation had been a complete success.

Question 37:

Which one of the following is the overall conclusion of the statement?

A. The error that occurred was a result of the failure of safety precautions already in place.
B. Surgeries should only be performed by surgeons who know their patients well.
C. The human element to medicine means errors will always occur.
D. The safety procedures surrounding surgical procedures need to be reviewed.
E. Some doctors are overconfident.

Question 38:

Which of the following is attributed as the original cause of the error?

A. The medical student not having asserted herself.
B. The poor handwriting in the chart.
C. The hierarchical system of medicine.
D. The registrar not having met the patient.
E. The patient being asleep.

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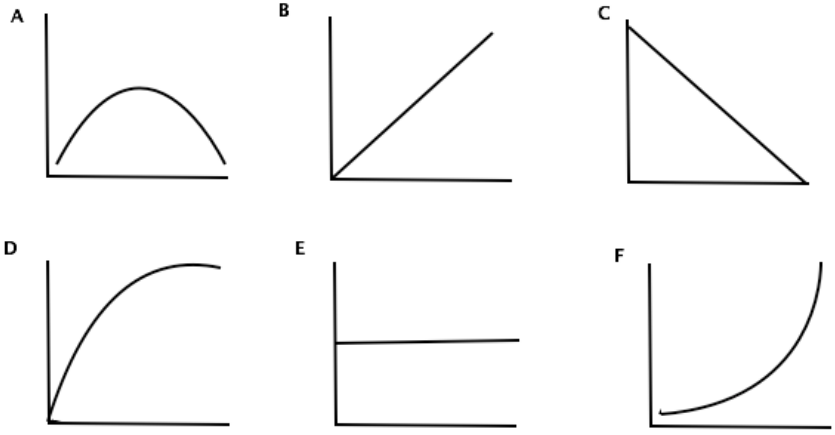
Question 39:

What does the 'tip of the iceberg' refer to in the passage?

A. Problems we face every day.
B. The probable large numbers of medical errors that go unreported.
C. The difficulties of surgery.
D. Reported medical errors.
E. Problems within the NHS.

Questions 40 and 41 also use the following graphs:

You may use the graphs below once, more than once, or not at all.



Question 40:

Which graph best describes the consultants' performance versus his interest in medicine over the course of his career?

A. A
B. B
C. C
D. D
E. E

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Question 41:

Which graphs best describe the medical knowledge acquired over time?

Option	Public Perception	Consultant's Perception
A	B	B
B	B	D
C	B	F
D	D	B
E	D	F

Question 42:

Sadly, in recent times, the lack of exercise associated with sedentary lifestyles has increased in the developed world. The lack of opportunity for exercise is endemic and these countries have also seen a rise of diseases such as diabetes even in young people. In these developed countries, health issues that are usually associated with old age, such as high blood pressure, are rapidly increasing in prevalence. These are however still uncommon in less developed countries, where most people are physically active throughout the entirety of their lives.

Which one of the following can be concluded from the passage above?

A. Exercise has a greater effect on old people than young people.
B. Maintenance of good health is associated with lifelong exercise.
C. Changes in lifestyle will be necessary to increase life expectancies in developed countries.
D. Exercise is only beneficial when continued into old age.
E. Obesity and diabetes are the result of lack of exercise.

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Questions 43 - 45 are based on the passage below:

'Midwives should now encourage women to, as often as possible, give birth at home. Not only is there evidence to suggest that normal births at home are as safe those as in hospital, but it removes the medicalisation of childbirth that emerged over the years. With the increase in availability of health resources we now, too often, use services such as a full medical team for a process that women have been completing single-handedly for thousands of years. Midwives are extensively trained to assist women during labour at home and capable enough to assess when there is a problem that requires a hospital environment. Expensive hospital births must and should move away from being standard practice, especially in an era where the NHS has far more demands on its services that it can currently afford.'

Question 43:

Which one of the following is the most appropriate conclusion from the statement?

A. People are over dependent on healthcare.
B. Some women prefer to have their babies in hospital.
C. Having a baby in hospital can actually be riskier than at home.
D. Childbirth has been over medicalised.
E. Encouraging women to have their babies at home may relieve some of the financial pressures on the NHS.

Question 44:

Which one of the following if true most weakens the argument presented in the passage above?

A. Some women are scared of home births.
B. Home births are associated with poorer outcomes.
C. Midwives do not like performing home visits.
D. Some home births result in hospital births anyway.
E. Medicalising childbirth is not a bad thing.

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Question 45:

Which one of the following describes what the statement cites as the cause for the 'medicalisation of childbirth'?

A. Women fear giving birth without a full medical team present.
B. Midwives are incapable of aiding childbirth without help.
C. Giving birth at home is not as safe as it used to be.
D. Excessive availability of health services.
E. Women only used to give birth at home because they could not do so at hospital.

Question 46:

We need to stop focussing so much attention on the dangers of fires. In 2011 there were only 242 deaths due to exposure to smoke, fire and flames, while there were 997 deaths from hernias. We need to think more proportionally; these statistics show that campaigns such as 'fire kills' are not necessary, as comparison with the risk from the death from hernias clearly shows that fires are not as dangerous as they are perceived to be.

Which of the following statements identify a weakness in the above argument?

1. More people may die in fires if there were no campaigns about their danger and how to prevent them.
2. The smoke of a fire is more dangerous than it flames.
3. There may be more people with hernias than those in fires.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2 only
E. 1 and 3 only

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Question 47:

A survey of a school was taken to find out whether there was any correlation between the sports students played and the subjects they liked. The findings were as follows: some football players liked Maths and some of them liked History. All students liked English. None of the basketball players liked History, but all of them, as well as some rugby players, liked Chemistry. All rugby players like Geography.

Based on the findings, which one of the below must be true?

A. Some of the footballers liked Maths and History.
B. Some of the rugby players liked three subjects.
C. Some rugby players liked History.
D. Some of the footballers liked English but did not like Maths and History.
E. Some basketball players like more than 3 subjects.

Question 48:

The control of illegal drug use is becoming increasingly difficult. New 'legal highs' are being manufactured which have slightly changed molecular structures from illegal compounds, so they are not technically illegal. These new 'legal drugs' are being brought onto the street at a rate of at least one per week, and so the authorities cannot keep up. Some health professionals therefore believe that the legality of drugs is becoming less relevant as to the potentially dangerous side effects. The fact that these new compounds are legal may however mean that the public are not aware of their equally high risks.

Which of the following are implied by the argument?

1. Some health professionals believe there is no value in making drugs illegal.
2. The major problem in controlling illegal drug use is the rapid manufacture of new drugs that are not classified as illegal.
3. The general public are not worried about the risks of legal or illegal highs.
4. There is no longer a good correlation between risk of drug taking and the legal status of the drug.

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A. 1 only
B. 2 only
C. 1 and 4
D. 2 and 4
E. 2 and 3

Question 49:

WilderTravel Inc. is a company which organises wilderness travel holidays, with activities such as trekking, mountain climbing, safari tours and wilderness survival courses. These activities carry inherent risks, so the directors of the company are drawing up a set of health regulations, with the aim of minimising the risks by ensuring that nobody participates in activities if they have medical complications meaning that doing so may endanger them. They consider the following guidelines:

'Persons with pacemakers, asthma or severe allergies are at significant risk of heart attack in low oxygen environments. People undertaking mountain climbing activities with WilderTravel frequently encounter environments with low oxygen levels.'

The directors therefore decide that in order to ensure the safety of customers on WilderTravel holidays, one step that must be taken is to bar those with pacemakers, asthma or allergies from partaking in mountain climbing.

Which of the following best illustrates a flaw in this reasoning?

A. Participants should be allowed to assess the safety risks themselves and should not be barred from activities if they decide the risk is acceptable.
B. They have assumed that all allergies carry an increased risk of heart attack, when the guidelines only say this applies to those with severe allergies.
C. The directors have failed to consider the health risks of people with these conditions taking part in other activities.
D. People with these conditions could partake in mountain climbing with other holiday organisers, and thus be exposed to danger of heart attack.
E. They could take more and better steps to help include people with these conditions, such as advising on medical treatment.

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Question 50:

Every winter in Britain, there are thousands of urgent callouts for ambulances in snowy conditions. The harsh conditions mean that ambulances cannot drive quickly and are delayed in reaching patients. These delays cause many injuries and medical complications, which could be avoided with quicker access to treatment. Despite this, very few ambulances are equipped with winter tyres or special tyre coverings to help the ambulances deal with snow. Clearly, if more ambulances were fitted with winter tyres, then we could avoid many medical complications that occur each winter.

Which of the following is an assumption made in this passage?

A. Ambulance drivers are capable of driving with winter tyres.
B. Ambulance trusts have sufficient funding to equip their vehicles with winter tyres.
C. Many medical complications could be avoided with quicker access to medical care.
D. There are no other alternatives to winter tyres that would allow ambulances to reach patients more quickly in snowy conditions.
E. Fitting winter tyres would allow ambulances to reach patients more quickly.

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Question 51:

St John's Hospital in Northumbria is looking to recruit a new consultant cardiologist, and interviews a series of candidates. The interview panel determines that 3 candidates are clearly more qualified for the role than the others, and they invite these 3 candidates for a second interview. During this second interview, and upon further examination of their previous employment records, it becomes apparent that Candidate 3 is the most proficient at surgery of the 3, whilst Candidate 1 is the best at patient interaction and explaining the risks of procedures. Candidate 2, meanwhile, ranks between the other 2 in both these aspects.

The hospital director tells the interviewing team that the hospital already has a well-renowned team dedicated to patient interaction, but the surgical success record at the hospital is in need of improvement. The director issues instructions that as a result it is more important that the new candidate is proficient at surgery, and patient interaction is less of a concern.

Which of the following is a conclusion that can be drawn from the Directors' comments?

A. The interviewing team should hire Candidate 2, in order to achieve a balance of good patient relations with good surgical records.
B. The interviewing team should hire Candidate 1, in order to ensure good patient interactions, as these are a vital part of a doctor's work.
C. The interviewing team should ignore the hospital director and assess the candidates further to see who would be the best fit.
D. The interviewing team should hire Candidate 3, in order to ensure that the new candidate has excellent surgical skills, to boost the hospital's success in this area.
E. The team should not hire any of them and re-open the job.

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Question 52:
Vaccinations have been one of the most outstanding and influential developments in medical history. Despite the huge successes, however, there is a strong anti-vaccination movement active in some countries, particularly the USA, who claim vaccines are harmful and ineffective.

There have been several high-profile events in recent years where anti-vaccine campaigners have been refused permission to enter countries for campaigns or have had venues refuse to host them due to the nature of their campaigns. Many anti-vaccination campaigners have claimed this is an affront to free speech, and that they should be allowed to enter countries and obtain venues without hindrance. However, although free speech is desirable, an exception must be made here because the anti-vaccination campaign spreads misinformation to parents, causing vaccination to rates to drop.

When this happens, preventable infectious diseases often begin to increase, causing avoidable deaths of innocent members of the community, particularly in children. Thus, in order to protect innocent people, we must continue to block the anti-vaccine campaigners from spreading misinformation freely by pressuring venues not to host anti-vaccination campaigners.

Which of the following best illustrates the principle that this argument follows?

A. Free speech is always desirable and must not be compromised under any circumstances.
B. The right of innocent people to protection from infectious diseases is more important than the right of free speech.
C. The right of free speech does not apply when the party speaking is lying or spreading misinformation.
D. Public health programmes that achieve significant success in reducing the incidence of disease should be promoted.
E. That free speech is acceptable, but in this case the campaigners are a direct source of harm.

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Question 53:

In order for a tumour to grow larger than a few centimetres, it must first establish its own blood supply by promoting angiogenesis. Roger has a tumour in his abdomen, which is investigated at the Royal General Hospital. During the tests, they detect newly formed blood vessels in the tumour, showing that it has established its own blood supply. Thus, we should expect the tumour to grow significantly, and become larger than a few centimetres. Action must be taken to deal with this.

Which of the following best illustrates a flaw in this reasoning?

A. It assumes that the tumour in Roger's abdomen has established its own blood supply.
B. It assumes that a blood supply is necessary for a tumour to grow larger than a few centimetres.
C. It assumes that nothing can be done to stop the tumour once a blood supply has been established.
D. It assumes that a blood supply is sufficient for the tumour to grow larger than a few centimetres.
E. It assumes that growth is significant after establishing its own blood supply, whereas it does not quantify this in the evidence.

Question 54:

In this year's Great North Run, there are several dozen people running to raise money for the Great North Air Ambulance (GNAA), as part of a large national fundraising campaign. If the runners raise £500,000 between them, then the GNAA will be able to add a new helicopter to its fleet. However, the runners only raise a total of £420,000. Thus, the GNAA will not be able to get a new helicopter.

Which of the following best illustrates a flaw in this passage?

A. It has assumed that the GNAA will not be able to acquire a new helicopter without the runners raising £500,000.
B. It has assumed that that GNAA wishes to add a new helicopter to its fleet.
C. It has assumed that the GNAA does not have better things to spend the money on.
D. It has assumed that some running in the Great North Run are raising money for the GNAA.
E. None of the above.

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Question 55:

Many courses, spanning Universities, colleges, apprenticeship institutions and adult skills courses should be subsidised by the government. This is because they improve the skills of those attending them. It has been well demonstrated that the more skilled people are, the more productive they are economically. Thus, government subsidies of many courses would increase overall economic productivity, and lead to increased growth.

Which of the following would most weaken this argument?

A. The UK already has a high level of growth and does not need to accelerate this growth.
B. Research has demonstrated that higher numbers of people attending adult skills courses results in increased economic growth.
C. Research has demonstrated that the cost of many courses (to those taking them) has little effect on the number of people undertaking the courses.
D. Employers often seek to employ those with greater skillsets and appoint them to higher positions.
E. Employers are able to subsidise people who want to partake in these sorts of courses, which is more appropriate.

Question 56:

Pluto was once considered the 9th planet in the solar system. However, further study of the planet led to it being reclassified as a dwarf planet in 2006. One key factor in this reclassification was the discovery of many objects in the solar system with similar characteristics to Pluto, which were also placed into this new category of 'Dwarf Planet'. Some astronomers believe that Pluto should remain classified as a planet, along with the many entities similar to Pluto that have been discovered. Considering all of this, it is clear that if we were to reclassify Pluto as a planet, and maintain consistency with classification of astronomical entities, then the number of planets would significantly increase.

Which of the following best illustrates the main conclusion of this passage?

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A. If Pluto is classified as a planet, then many other entities should also be planets, as they share similar characteristics.
B. Some astronomers believe Pluto should be classified as a planet.
C. Pluto should not be classified as a planet, as this would also require many other entities to be classified as planets to ensure consistency.
D. If Pluto is to be classified as a planet, then the number of objects classified as planets should increase significantly.
E. We should classify all objects that are similar in the same category.

Question 57:
2 trains depart from Birmingham at 5:30 pm. One of the trains is heading to London, whilst the other is heading to Glasgow. The distance from Birmingham to Glasgow is three times longer than the distance from Birmingham to London, and the train to London arrives at 6:30 pm. Thus, the train to Glasgow will arrive at 8:30pm.

Which of the following is an assumption made in this passage?
A. Both trains depart at the same time.
B. Both trains depart from Birmingham.
C. Both trains travel at the same speed.
D. The train heading to Glasgow has to travel three times as far as the train heading to London.
E. Both trains travel the most direct way.

Question 58:
Carcinogenesis, oncogenesis and tumorigenesis are various names given to the generation of cancer, with the term literally meaning 'creation of cancer'. In order for carcinogenesis to happen, there are several steps that must occur. Firstly, a cell (or group of cells) must achieve immortality, and escape senescence (the inherent limitation of a cell's lifespan). Then they must escape regulation by the body and begin to proliferate in an autonomous way. They must also become immune to apoptosis and other cell death mechanisms. Finally, they must avoid detection by the immune system, or survive its responses. If a single one of these steps fails to occur, then carcinogenesis will not be able to occur.

Which of the following is a conclusion that can be reliably drawn from this passage?

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A. Several steps are essential for carcinogenesis.
B. If all the steps mentioned occur, then carcinogenesis will definitely occur.
C. The immune system is unable to tackle cells that have escaped regulation by the body.
D. There are various mechanisms by which carcinogenesis can occur.
E. The terminology for the creation of cancer is confusing.

Question 59:
P53 is one of the most crucial genes in the body, responsible for detecting DNA damage and halting cell replication until repair can occur. If repair cannot take place, P53 will signal for the cell to kill itself. These actions are crucial to prevent carcinogenesis, and a loss of functional P53 is identified in over 50% of all cancers. The huge importance of P53 towards protecting the cell from damaging mutations has led to it deservedly being known as 'the guardian of the genome'. The implications of this name are clear – any cell that has a mutation in P53 is at serious risk of developing a potentially dangerous mutation.

Which of the following CANNOT be reliably concluded from this passage?
A. P53 is responsible for detecting DNA damage.
B. Most cancers have lost functional P53.
C. P53 deserves its name 'guardian of the genome'.
D. A cell that has a mutation in P53 will develop damaging mutations.
E. None of the above.

Question 60:
Sam is buying a new car and needs to decide whether to buy a petrol or a diesel model. He knows he will drive 9,000 miles each year. He calculates that if he drives a petrol car, he will spend £500 per 1,000 miles on fuel, but if he buys a diesel model, he will only spend £300 per 1,000 miles on fuel. He calculates, therefore, that if he purchases a diesel car, then this year he would make a saving of £1800, compared to if he bought the petrol car.

Which of the following is NOT an assumption that Sam has made?

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A. The price of diesel will not fluctuate relative to that of petrol.
B. The cars will have the same initial purchase cost.
C. The cars will have the same costs for maintenance and garage expenses.
D. The cars will use the same amount of fuel.
E. All of the above are assumptions.

Question 61:
In the UK, cannabis is classified as a Class B drug, with a maximum penalty of up to 5 years imprisonment for possession, or up to 14 years for possession with intent to supply. The justification for drug laws in the UK is that classified drugs are harmful, addictive, and destructive to people's lives. However, available medical evidence indicates that cannabis is relatively safe, non-addictive and harmless. In particular, it is certainly shown to be less dangerous than alcohol, which is freely sold and advertised in the UK. The fact that alcohol can be freely sold and advertised, but cannabis, a less harmful drug, is banned highlights the gross inconsistencies in UK drugs policy.

Which of the following best illustrates the main conclusion of this passage?
A. Cannabis is a less dangerous drug than alcohol.
B. Alcohol should be banned, so we can ensure consistency in the UK drug policy.
C. Cannabis should not be banned, and should be sold freely, in order to ensure consistency in the UK drug policy.
D. The UK government's policy on drugs is grossly inconsistent.
E. Alcohol should not be advertised in the UK.

Question 62:
Every year in Britain, there are thousands of accidents at people's homes such as burns, broken limbs and severe cuts, which cause a large number of deaths and injuries. Despite this, very few households maintain a sufficient first aid kit equipped with bandages, burn treatments, splints and saline to clean wounds. If more households stocked sufficient first aid supplies, many of these accidents could be avoided.

Which of the following best illustrates a flaw in this argument?

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A. It ignores the huge cost associated with maintaining good first aid supplies.
B. It assumes that people know how to use first aid equipment.
C. It ignores the many accidents that could not be treated even if first aid supplies were readily available.
D. It neglects to consider the need for trained first aid persons in order for first aid supplies to help in reducing the severity of injuries caused by accidents.
E. It implies that presence of first aid equipment will lead to fewer accidents

Question 63:

Researchers at SmithJones Inc., an international drug firm, are investigating a well-known historic compound, which is thought to reduce levels of DNA replication by inhibiting DNA polymerases. It is proposed that this may be able to be used to combat cancer by reducing the proliferation of cancer cells, allowing the immune system to combat them before they spread too far and become too damaging. Old experiments have demonstrated the effectiveness of the compound via monitoring DNA levels with a dye that stains DNA red, thus monitoring the levels of DNA present in cell clusters. They report that the compound is observed to reduce the rate at which DNA replicates. However, it is known that if researchers use the wrong solutions when carrying out these experiments, then the amount of red staining will decrease, suggesting DNA replication has been inhibited, even if it is not inhibited. As several researchers previously used this wrong solution, we can conclude that these experiments are flawed, and do not reflect what is actually happening.

Which of the following best illustrates a flaw in this argument?

A. From the fact that the compound inhibits DNA replication, it cannot be concluded that it has potential as an anticancer drug.
B. From the fact that the wrong solutions were used, it cannot be concluded that the experiments may produce misleading results.
C. From the fact that the experiments are old, it cannot be concluded that the wrong solutions were used.
D. From the fact that the compound is old, it cannot be concluded that it is safe.
E. Very little can be concluded without more information.

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Question 64:

Rotherham football club are currently top of the league, with 90 points. Their closest competitors are South Shields football club, with 84 points. Next week, the teams will play each other, and after this, they each have 2 games left before the end of the season. Each win is worth 3 points, a draw is worth 1 point, and a loss is worth 0 points. Thus, if Rotherham beat South Shields, they will win the league (as they will then be 9 points clear, and South Shields would only be able to earn 6 more points).

In the match of Rotherham vs. South Shields, Rotherham are winning until the 85th minute, when Alberto Simeone scores an equaliser for South Shields, and South Shields then go on to win the match. Thus, Rotherham will not win the league.

Which of the following best illustrates a flaw in this passage's reasoning?

A. It has assumed that Alberto Simeone scored the winning goal for South Shields.
B. It has assumed that beating South Shields was necessary for Rotherham to win the league, when in fact it was only sufficient.
C. Rotherham may have scored an equaliser later in the game, and not lost the match.
D. It has failed to consider what other teams might win the league.
E. It is assumed that Rotherham are better than everyone else.

Question 65:

Oakville Supermarkets is looking to build a new superstore, and a meeting of its directors has been convened to decide where the best place to build the supermarket would be. The Chairperson of the Board suggests that the best place would be Warrington, a town that does not currently have a large supermarket and would thus give them an excellent share of the shopping market.

However, the CEO notes that the population of Warrington has been steadily declining for several years, whilst Middlesbrough has recently been experiencing high population growth. The CEO therefore argues that they should build the new supermarket in Middlesbrough, as they would then be within range of more people, and so of more potential customers.

Which of the following best illustrates a flaw in the CEO's reasoning?

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A. Middlesbrough may already have other supermarkets, so the new superstore may get a lower share of the town's shoppers.
B. Despite the recent population changes, Warrington may still have a larger population than Middlesbrough.
C. Middlesbrough's population is projected to continue growing, whilst Warrington's is projected to keep falling.
D. Many people in Warrington travel to Liverpool or Manchester, 2 nearby major cities, in order to do their shopping.
E. None of the above.

Question 66:

Global warming is a key challenge facing the world today, and the changes in weather patterns caused by this phenomenon have led to the destruction of many natural habitats, causing many species to become extinct. Recent data has shown that extinctions have been occurring at a faster rate over the last 40 years than at any other point in the earth's history, exceeding the great Permian mass extinction, which wiped out 96% of life on earth. If this rate continues, over 50% of species on earth will be extinct by 2100. It is clear that in the face of this huge challenge, conservation programmes will require significantly increased levels of funding in order to prevent most of the species on earth from becoming extinct.

Which of the following are assumptions in this argument?

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 67:

After an election in Britain, the new government is debating what policy to adopt on the railway system, and whether it should be entirely privatised, or whether public subsidies should be used to supplement costs and ensure that sufficient services are run. Studies in Austria, which has high public funding for railways, have shown that the rail service is used by many people, and is highly thought of by the population. However, this is clearly down to the fact that Austria has many mountainous and high-altitude areas, which experience significant amounts of snow and ice. This makes many roads impassable and travelling by road difficult. Thus, rail is often the only way to travel, explaining the high passenger numbers and approval ratings. Thus, the high public subsidies clearly have no effect.

Which of the following, if true, would weaken this argument?

1. France also has high public subsidy of railways but does not have large areas where travel by road is difficult. The French railway also has high passenger numbers and approval ratings.
2. Italy also has high public subsidy of railways, but the local population dislike using the rail service, and it has poor passenger numbers.
3. There are many reasons affecting the passenger numbers and approval ratings of a given country's rail service.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 68:
In 2001-2002, 1019 patients were admitted to hospital due to obesity. This figure was more than 11 times higher by 2011-12 when there were 11,736 patients admitted to hospital with the primary reason for admission being obesity. Data has shown higher percentages of both men and women were either obese or overweight in 2011 compared to 1993, with the percentage of people being overweight climbing from 58% to 65%, and female from 49% to 58%. Rates of adult obesity have increased even more steeply within this period – 13% to 24% for men and 16% to 26% for women.

Studies in 2011 found that nearly a third of children between 2 – 15 years were either overweight or obese, although this was not significantly higher than in 2008. Lifestyles are also becoming less healthy, with a decline in both children and adults eating the recommended number of fruit and vegetables each day and taking the recommended amount of exercise each week. The ease and availability of cheap fast-food outlets may be partly to blame for the rising number of obese people. Education is required to teach people the importance of a healthy lifestyle, however people must take some personal responsibility for their health.

Using only information from the passage, which of the following statements is correct?

A. In 2011, there was a higher proportion of obese men than women.
B. Obesity rates are rising steeply for both males and females of all age groups.
C. A combination of education and personal responsibility is needed to improve the population's health
D. The main reason people eat fast food is because it's cheaper
E. Part of the reason for the increase in numbers is a larger population.

Question 69:
Tobacco companies sell cigarettes despite being fully aware that cigarettes cause significant harm to the wellbeing of those that smoke them. Diseases caused or aggravated by smoking cost billions of pounds for the NHS to treat each year. This is extremely irresponsible behaviour from the tobacco companies. Tobacco companies should be taxed, and the money raised put towards funding the NHS.

Which of the following conclusions CANNOT be drawn from the above?

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A. There is a connection between lung cancer and smoking.
B. There is a connection between liver disease and smoking.
C. There is a connection between oral cancer and smoking.
D. All smokers drink excessively.
E. All of the above.

Question 70:
Investigations in the origins of species suggest that humans and the great apes have the same ancestors. This is suggested by the high degree of genetic similarity between humans and chimpanzees (estimated at 99%). At the same time there is an 84% homology between the human genome and that of pigs. This raises the interesting question of whether it would be possible to use pig or chimpanzee organs for the treatment of human disease.

Which conclusion can be reasonably drawn from the above article?
A. Pigs and chimpanzees have a common ancestor.
B. Pigs and humans have a common ancestor.
C. It can be assumed that chimpanzees will develop into humans if given enough time.
D. There seems to be great genetic homology across a variety of species.
E. Organs from pigs or chimpanzees present a good alternative for human organ donation.

Question 71:
Poor blood supply (a result of vascular disease) to a part of the body can cause damage to the affected tissue - i.e. lead to an infarction. There are a variety of known risk factors for vascular disease. Diabetes is a major risk factor. Other risk factors are more dependent on the individual as they represent individual choices such as smoking, poor dietary habits, and insufficient exercise. In some cases, blood supply to the limbs and in particular the feet can become so poor that patches of tissue die. This is known as necrosis and is marked by affected area of the body turning black. Necrotic tissue is usually removed in surgery.

Which of the following statements CANNOT be concluded from the information in the above passage?

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A. Smoking causes vascular disease.
B. Diabetes causes vascular disease.
C. Vascular disease always leads to infarctions.
D. Necrotic tissue must be removed surgically.
E. All of the above

Question 72:
People who can afford to pay for private education should not have access to the state school system. This would allow more funding for students from lower income backgrounds. More funding will provide better resources for students from lower income backgrounds and will help to bridge the gap in educational attainment between students from higher income and lower income backgrounds.

Which of the following statements, if true, would most strengthen the above argument?

A. Educational attainment is a significant factor in determining future prospects.
B. Providing better resources for students has been demonstrated to lead to an increase in educational attainment.
C. Most people who can afford to do so choose to purchase private education for their children.
D. A significant gap exists in educational attainment between students from high income and low-income backgrounds.
E. Most schools currently receive a similar amount of funding relative to the number of students in the school.

Question 73:
Increasing numbers of people are choosing to watch films on DVD in recent years. In the past few years, cinemas have lost customers, causing them to close down. Many cinemas have recently closed, removing an important focal point for many local communities and causing damage to those communities. Therefore, we should ban DVDs in order to help local communities.

Which of the following best states an assumption made in this argument?

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A. The cinemas that have recently closed have done so because of reduced profits due to people choosing to watch DVDs instead.
B. Cinemas being forced to close causes damage to local communities.
C. DVDs are improving local communities by allowing people to meet up and watch films together.
D. Sales of DVDs have increased due to economic growth.
E. Local communities have called for DVDs to be banned.

Question 74:
Aeroplanes are the fastest form of transport available. An aeroplane can travel a given distance in less time than a train or a car. John needs to travel from Glasgow to Birmingham. If he wants to arrive as soon as possible, he should travel by aeroplane.

Which of the following best illustrates a flaw in this argument?
A. One day, there could be faster cars built that could travel as fast as aeroplanes.
B. Travelling by air is often more expensive.
C. It ignores the time taken to travel to an airport and check in to a flight, which may mean he will arrive later if travelling by aeroplane.
D. John may not own a car, and thus may not have any other option.
E. John may not be legally allowed to make the journey.

Question 75:
During autumn, spiders frequently enter people's homes to escape the cold weather. Many people dislike spiders and seek ways to prevent them from entering properties, leading to spider populations falling as they struggle to cope with the cold weather. Studies have demonstrated that when spider populations fall, the population of flies rises. Higher numbers of flies are associated with an increase in food poisoning cases. Therefore, people must not try to prevent spiders from entering their homes.

Which of the following best illustrates the main conclusion of this argument?

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A. People should not dislike spiders being present in their homes.
B. People should seek methods to prevent flies from entering their homes.
C. People should actively encourage spiders to occupy their homes to increase biodiversity.
D. People should accept the presence of spiders in their homes to reduce the incidence of food poisoning.
E. Spiders should be cultivated and used as a biological pest control to combat flies.

Question 76:

Each year, thousands of people acquire infections during prolonged stays at hospital. Concurrently, bacteria are becoming resistant to antibiotics at an ever-increasing rate. In spite of this, progressively fewer pharmaceutical companies are investing in research into new antibiotics, and the number of antibiotics coming onto the market is decreasing. As a result, the number of antibiotics that can be used to treat infections is falling. If pharmaceutical companies were pressured into investing in new antibiotic research, many lives could be saved.

Which of the following best illustrates a flaw in this argument?

A. It assumes the infections acquired during stays at hospital are resulting in deaths.
B. It ignores the fact that many people never have to stay in hospital.
C. It does not take into account the fact that antibiotics do not produce much profit for pharmaceutical companies.
D. It ignores the fact that some hospital-acquired infections are caused by organisms that cannot be treated by antibiotics, such as viruses.
E. It assumes that bacterial resistance to antibiotics has not been happening for some time.

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Question 77:

Katherine has shaved her armpits most of her adult life but has now decided to stop. She explains her reasons for this to John, saying she does not like the pressure society puts on women to be shaven in this area. John listens to her reasons, but ultimately responds 'just because you explain why I should find your hairiness attractive; it does not mean I will. I will find you unattractive, as I do not like girls with hair on their arm pits.'

What assumption has John made?

A. That just because he finds Katherine unattractive, he would find other girls with unshaven arm pits unattractive.
B. That Katherine is trying to make John find her armpit hair attractive.
C. That Katherine will never conceal her armpit hair.
D. Katherine must be wrong, because she is a woman.
E. That Katherine thinks women should stop shaving.

Question 78:

Medicine has improved significantly over the last century. Better medicine causes a reduction in the death rate from all causes. However, as people get older, they suffer from infectious disease more readily.

Many third world countries have a high rate of deaths from infectious disease. Sunita argues that this high death rate is caused by better medicine, which has given rise to an ageing population, resulting in a high rate of deaths from infectious disease as elderly people suffer from infectious disease more readily. Sunita believes that better medicine is therefore indirectly responsible for this high death rate from infectious disease.

However, this cannot be the case. In third world countries, most people do not live to old age, often dying from infectious disease at a young age. Therefore, an ageing population cannot be the reason behind the high rate of death from infectious disease. As better medicine causes a reduction in the death rate from all causes, it is clear that better medicine will lead to a reduction in the death rate from infectious disease in third world countries.

Which of the following best states the main conclusion of this argument?

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A. We can expect that improvements in medicine seen over the last century will increase life expectancy.
B. Better medicine is not responsible for the increased prevalence of infectious disease in third world countries.
C. Better medicine has caused the overall death rate of third world countries to increase.
D. Better medicine will cause a decrease in the rate of death from infectious disease in third world countries.
E. As people get older, they suffer from infectious disease more readily.

Question 79:
Bristol and Cardiff are 2 cities with similar demographics and are located in a roughly similar area of the UK. Bristol has higher demand for housing than Cardiff. Therefore, a house in Bristol will cost more than a similar house in Cardiff.

Which of the following best illustrates an assumption in the statement above?
A. House prices will be higher if demand for housing is higher.
B. People can commute from Cardiff to Bristol.
C. Supply of housing in Cardiff will not be lower than in Bristol.
D. Bristol is a better place to live.
E. Cardiff has sufficient housing to provide for the needs of its communities.

Question 80:
Jellicoe Motors is a small motor company in Sheffield, employing 3 people. The company is hiring a new mechanic and interviews several candidates. New research into production lines has indicated that having employees with a good ability to work as part of a team boosts a company's productivity and profits. Therefore, Jellicoe motors should hire a candidate with good team-working skills.

Which of the following best illustrates the main conclusion of this argument?

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A. Jellicoe Motors should not hire a new mechanic.
B. Jellicoe motors should hire a candidate with good team-working skills in order to boost their productivity and profits.
C. Jellicoe motors should hire several new candidates to form a good team and boost their productivity.
D. If Jellicoe motors does not hire a candidate with good team-working skills, they may struggle to be profitable.
E. Jellicoe motors should not listen to the new research.

Question 81:
Research into new antibiotics does not normally hold much profit for pharmaceutical firms. As a consequence, many firms are not investing in antibiotic research, and very few new antibiotics are being produced. However, with bacteria becoming increasingly resistant to current antibiotics, new ones are desperately needed to avoid running the risk of thousands of deaths from bacterial infections. Therefore, the UK government must provide financial incentives for pharmaceutical companies to invest in research into new antibiotics.

Which of the following best expresses the main conclusion of this argument?
A. If bacterial antibiotic resistance continues, there could be thousands of deaths from bacterial infections.
B. Pharmaceutical firms are not investing in new antibiotic research due to a lack of potential profit.
C. If the UK government invests in research into new antibiotics, thousands of lives will be saved.
D. The pharmaceutical firms should invest in areas of research that are profitable and ignore antibiotic research.
E. The UK government must provide financial incentives for pharmaceutical firms to invest into antibiotic research if it wishes to avoid risking thousands of deaths from bacterial infections.

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Question 82:

People in developing countries use far less water per person than those in developed countries. It is estimated that at present, people in the developing world use an average of 30 litres of water per person per day, whilst those in developed countries use on average 70 litres of water per person per day. It is estimated that for the current world population, an average water usage of 60 litres per person per day would be sustainable, but any higher than this would be unsustainable.

The UN has set development targets such that in 20 years, people living in developing countries will be using the same amount of water per person per day as those living in developed countries. Assuming the world population stays constant for the next 20 years, if these targets are met the world's population will be using water at an unsustainable rate.

Which of the following, if true, would most weaken the argument above?

A. The prices of water bills are dropping in developed countries like the UK.
B. The level of water usage in developed countries is falling and may be below 60 litres per person per day in 20 years.
C. The population of all developing countries is less than the population of all developed countries.
D. Climate change is likely to decrease the amount of water available for human use over the next 20 years.
E. The UN's development targets are unlikely to be met.

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Question 83:
For a senior management job at a company, the right candidate will be someone who can keep a cool head in a crisis and react quickly to events. The applicant says he suffers from a phobia about flying, and panics when an aircraft is landing, and so he would prefer not to travel abroad on business if it could be avoided. He is obviously a very nervous type of person who would clearly panic in an emergency and fail to provide the leadership qualities necessary for the job. Therefore, this person is not a suitable candidate for the post.

Which of the following highlights the biggest flaw in the argument above?
A. It falsely assumes that phobias are untreatable or capable of being eliminated.
B. It falsely assumes that the person appointed to the job will need to travel abroad.
C. It falsely assumes that a specific phobia indicates a general tendency to panic.
D. It falsely assumes that people who stay cool in a crisis will be good leaders.
E. It fails to take into account other qualities the person might have for the post.

Question 84:
There are significant numbers of people attending university every year, as many as 45% of 18-year-olds. As a result, there are many more graduates entering the workforce with better skills and better earning potential. Going to university makes economic sense and we should encourage as many people to go there as possible.

Which of the following highlights the biggest flaw in the argument above?
A. There are no more university places left.
B. Students can succeed without going to university.
C. Not all degrees equip students with the skills needed to earn higher salaries.
D. Some universities are better than others.
E. It costs lots of money to send a student to university.

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Question 85:

Young people spend too much time watching television, which is bad for them. Watching excessive amounts of TV is linked to obesity, social exclusion and can cause eye damage. If young people were to spend just one evening a week playing sport or going for a walk the benefits would be manifold. They would lose weight, feel better about themselves and it would be a sociable activity. Exercise is also linked to strong performance at school and so young people would be more likely to perform well in their exams.

Which of the following highlights the biggest flaw in the argument above?

A. Young people can watch sport on television.
B. There are many factors that affect exam performance.
C. Television does not necessarily have any damaging effect.
D. It assumes people watch TV every night.
E. Television and sport are not linked.

Question 86:

Campaigners pushing for legalisation of cannabis have many arguments for their cause. Most claim there is little evidence of cannabis causing any adverse effects on health, that many otherwise law-abiding people are users of cannabis, and that in any case, prohibition of drugs does not reduce their usage. Legalising cannabis would also reduce crime associated with drug trafficking and would provide an additional revenue stream for the government.

Which of the following best represents the conclusion of the passage?

A. Regular cannabis users are unlikely to have health problems.
B. Legalising cannabis would be good for cannabis users.
C. There are multiple reasons to legalise cannabis.
D. Prohibition is an effective measure to reduce drug usage.
E. Drug associated crime would reduce if cannabis was legal.

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Question 87:
Mohan has been offered a new job in Birmingham, starting in several months with a fixed salary. In order to ensure he can afford to live in Birmingham on his new salary, Mohan compares the prices of some houses in Birmingham. He finds that a 2-bedroom house will cost £200,000. A 3-bedroom house will cost £250,000. A 4-bedroom house with a garden will cost £300,000.

Mohan's bank tells him that if he is earning the salary of the job he has been offered, they will grant him a mortgage for a house costing up to £275,000. After a month of deliberation, Mohan accepts the job and decides to move to Wolverhampton. He begins searching for a house to buy. He reasons that he will not be able to purchase a 4-bedroomed house.

Which of the following is NOT an assumption that Mohan has made?

A. A house in Wolverhampton will cost the same as a similar house in Birmingham.
B. A different bank will not offer him a mortgage for a more expensive house on the same salary.
C. The salary for the job could increase, allowing him to purchase a more expensive house.
D. A 4-bedroomed house without a garden will not cost less than a 4-bedroomed house with a garden.
E. House prices in Birmingham will not have fall between now and when Mohan purchases a house.

Question 88:
We should teach the Holocaust in schools. It is important that young people see what it was like for Jewish people under Nazi rule. If we expose the harsh realities to impressionable people, then this will help improve tolerance of other races. It will also prevent other such terrible events happening again.

Which of the following best represents the conclusion of the passage?

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A. We should teach about the Holocaust in schools.
B. The Holocaust was a tragedy.
C. The Nazis were evil.
D. We should not let terrible events happen again.
E. Educating people is the best solution to the world's problems.

Question 89:
The popular series 'Game of Thrones' should not be allowed on television because it shows scenes of a disturbing nature, in particular scenes of rape. Children may find themselves watching the programme on TV, and then going on to commit the terrible crime of rape, mimicking what they have watched.

Which of the following best illustrates a flaw in this argument?
A. Children may also watch the show on DVD.
B. Adults may watch the show on television.
C. Watching an action does not necessarily lead to recreating the action yourself.
D. There are lots of non-violent scenes in the show.
E. None of the above.

Question 90:
The TV series 'House of Cards' teaches us all a valuable lesson: the world is not a place that rewards kind behaviour. The protagonist of the series, Frank Underwood, uses intrigue and guile to achieve his goals, and through clever political tactics he is able to climb in rank. If he were to be kinder to people, he would not be able to be so successful. Success is predicated on his refusal to conform to conventional morality. The TV series should be shown to small children in schools, as it could teach them how to achieve their dreams.

Which of the following is an assumption made in the argument?
A. Children pay attention to school lessons.
B. The TV series is sufficiently entertaining.
C. One cannot both obey a moral code and succeed.
D. Frank Underwood is a likable character.
E. None of the above.

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Question 91:

Freddy makes lewd comments about a female passer-by's body to his friend, Neil, loud enough for the woman in question to hear. Neil is uncomfortable with this, and states that it is inappropriate for Freddy to do so, and that Freddy is being sexist. Freddy refutes this, and Neil retorts that Freddy would not make these comments about a man's body. Freddy replies by saying 'it is not sexist, I am a feminist, I believe in equality for men and women.'

Which of the following describes a flaw made in Freddy's logic?

A. A self-proclaimed feminist could still say a sexist thing.
B. The female passer-by in question felt uncomfortable.
C. Neil, too, considers himself a feminist.
D. It would still not be acceptable to make lewd comments at male passers-by.
E. Lewd comments are always inappropriate.

Question 92:

The release of CO_2 from consumption of fossil fuels is the main reason behind global warming, which is causing significant damage to many natural environments throughout the world. One significant source of CO_2 emissions is cars, which release CO_2 as they use up petrol. In order to tackle this problem, many car companies have begun to design cars with engines that do not use as much petrol. However, engines which use less petrol are not as powerful, and less powerful cars are not attractive to the public. If a car company produces cars which are not attractive to the public, they will not be profitable.

Which of the following best illustrates the main conclusion of this argument?

A. Car companies which produce cars that use less petrol will not be profitable.
B. The public prefer more powerful cars.
C. Car companies should prioritise profits over helping the environment.
D. Car companies should seek to produce engines that use less petrol but are still just as powerful.
E. The public are not interested in helping the environment.

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SECTION 1: PROBLEM SOLVING QUESTIONS

Section 1 problem solving questions are arguably the hardest to prepare for. However, there are some useful techniques you can employ to solve some types of questions much more quickly:

Construct Equations

Some of the problems in Section 1 are quite complex and you'll need to be comfortable with turning prose into equations and manipulating them. For example, when you read "Mark is twice as old as Jon" – this should immediately register as M = 2J. Once you get comfortable forming equations, you can start to approach some of the harder questions in this book (and past papers) which may require you to form and solve simultaneous equations. Consider the example:

Nick has a sleigh that contains toy horses and clowns and counts 44 heads and 132 legs in his sleigh. Given that horses have one head and four legs, and clowns have one head and two legs, calculate the difference between the number of horses and clowns.

A. 0
B. 5
C. 22
D. 28
E. 132

To start with, let C= Clowns and H= Horses.
For Heads: C + H = 44
For Legs: 2C + 4H = 132

This now sets up your two equations that you can solve simultaneously.

C = 44 - H so 2 (44 - H) + 4H = 132
Thus, 88 – 2H + 4H = 132.
Therefore, 2H = 44 so H = 22
Substitute back in to give C = 44 – H = 44 – 22 = 22

Thus, the difference between horses and clowns = C - H = 22 - 22 = 0

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It's important you are able to do these types of questions quickly (and **without resorting to trial & error**) as they are commonplace in section 1.

Spatial Reasoning

There are usually 1-2 spatial reasoning questions every year. They usually give nets for a shape or a patterned cuboid and ask which options are possible rotations. Unfortunately, they are extremely difficult to prepare for because the skills necessary to solve these types of questions can take a very long time to improve. The best thing you can do to prepare is to familiarise yourself with the basics of how cube nets work and what the effect of transformations are e.g. what happens if a shape is reflected in a mirror etc.

It is also a good idea to try to learn to draw basic shapes like cubes from multiple angles if you can't do so already. Finally, remember that if the shape is straightforward like a cube, it might be easier for you to draw a net, cut it out and fold it yourself to see which of the options are possible.

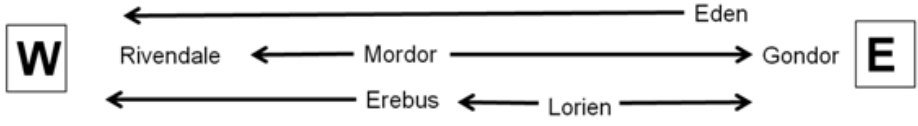
Diagrams

When a question asks about timetables, orders or sequences, draw out diagrams. By doing this, you can organise your thoughts and help make sense of the question.
"Mordor is West of Gondor but East of Rivendale. Lorien is midway between Gondor and Mordor. Erebus is West of Mordor. Eden is not East of Gondor."

*Which of the following **cannot** be concluded?*

A. Lorien is East of Erebus and Mordor.
B. Mordor is West of Gondor and East of Erebus.
C. Rivendale is west of Lorien and Gondor.
D. Gondor is East of Mordor and East of Lorien
E. Erebus is West of Mordor and West of Rivendale.

Whilst it is possible to solve this in your head, it becomes much more manageable if you draw a quick diagram and plot the positions of each town:



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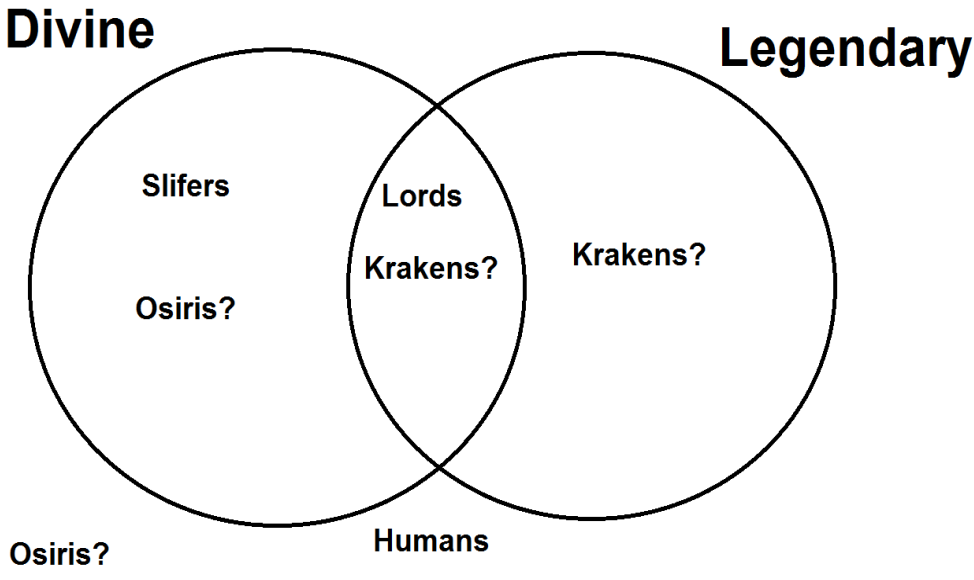
Now, it's a simple case of going through each option and seeing if it is correct according to the diagram. You can now easily see that Option E is wrong – Erebus cannot be west of Rivendale.

Don't feel that you have to restrict yourself to linear diagrams like this either – for some questions you may need to draw tables or even Venn diagrams. Consider this example:

Slifers and Osiris are not legendary. Krakens and Minotaurs are legendary. Minotaurs and Lords are both divine. Humans are neither legendary nor divine.

A. Krakens may be only legendary or legendary and divine.
B. Humans are not divine.
C. Slifers are only divine.
D. Osiris may be divine.
E. Humans and Slifers are the same in terms of both qualities.

Constructing a Venn diagram allows us to quickly see that the position of Osiris and Krakens aren't certain. Thus, A and D must be true. Humans are neither so B is true. Krakens may be divine, so A is true. E cannot be concluded as Slifers are divine but are humans are not. Thus, E is False.



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PROBLEM SOLVING QUESTIONS

Question 93:

Pilbury is south of Westside, which is south of Harrington. Twotown is north of Pilbury and Crewville but not further north than Westside. Crewville is:

A. South of Westside, Pilbury and Harrington but not necessarily Twotown.
B. North of Pilbury, and Westside.
C. South of Westside and Twotown, but north of Pilbury.
D. South of Westside, Harrington and Twotown but not necessarily Pilbury.
E. South of Harrington, Westside, Twotown and Pilbury.

Question 94:

The hospital coordinator is making the rota for the ward for next week; two of Drs Evans, James and Luca must be working on weekdays, none of them on Sundays and all of them on Saturdays. Dr Evans works 4 days a week including Mondays and Fridays. Dr Luca cannot work Monday or Thursday. Only Dr James can work 4 days consecutively, but he cannot do 5.

What days does Dr James work?

A. Saturday, Sunday and Monday.
B. Monday, Tuesday, Wednesday, Thursday and Saturday.
C. Monday, Thursday Friday and Saturday.
D. Tuesday, Wednesday, Friday and Saturday.
E. Monday, Tuesday, Wednesday, Thursday and Friday.

Question 95:

Michael, a taxi driver, charges a call out rate and a rate per mile for taxi rides. For a 4-mile ride he charges £11, and for a 5-mile ride, £13.

How much does he charge for a 9-mile ride?

A. £15
B. £17
C. £19
D. £20
E. £21

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Question 96:

Goblins and trolls are not magical. Fairies and goblins are both mythical. Elves and fairies are magical. Gnomes are neither mythical nor magical.

Which of the following is **FALSE**?

A. Elves may be only magical or magical and mythical.
B. Gnomes are not mythical.
C. Goblins are only mythical.
D. Trolls may be mythical.
E. Gnomes and goblins are the same in terms of both qualities.

Question 97:

Jessica runs a small business making bespoke wall tiles. She has just had a rush order for 100 tiles placed that must be ready for today at 7pm. The client wants the tiles packed all together, a process which will take 15 minutes. Only 50 tiles can go in the kiln at any point, and they must be put in the kiln to heat for 45 minutes. The tiles then sit in the kiln to cool before they can be packed, a process which takes 20 minutes. While tiles are in the kiln Jessica can decorate more tiles at a rate of 1 per minute.

What is the latest time Jessica can start making the tiles?

A. 2:55pm
B. 3:15pm
C. 3:30pm
D. 3:45pm
E. 2.50pm

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Question 98:

At a Pizza Parlour, you can order single, double or triple cheese in the crust. You also have the option to include ham, olives, pepperoni, bell pepper, meat balls, tomato slices, and pineapples.

How many different types of pizza are available at the Pizza Parlour?

A. 10
B. 96
C. 192
D. 384
E. 768

Question 99:

A woman has two children: Melissa and Jack. Their birthdays are 3 months apart, both on the 22nd of different months. The woman wishes to continue the trend of her children's names beginning with the same letter as the month they were born.

If her next child, Alina, is born on the 22nd – 2 months after Jack's birthday – how many months after Alina is born will Melissa have her next birthday?

A. 2 months
B. 4 months
C. 5 months
D. 6 months
E. 7 months

Question 100:

Policemen work in pairs. PC Carter, PC Dirk, PC Adams and PC Bryan must work together but not for more than seven days in a row, which PC Adams and PC Bryan now have done. PC Dirk has worked with PC Carter for 3 days in a row. PC Carter does not want to work with PC Adams.

Who should work with PC Bryan?

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A. PC Carter
B. PC Dirk
C. PC Adams
D. Nobody is available under the guidelines above.
E. Either PC Carter or PC Dirk.

Question 101:
My hair-dressers charges £30 for a haircut, £50 for a cut and blow-dry, and £60 for a full hair dye. They also do manicures, of which the first costs £15 and includes a bottle of nail polish, but are subsequently reduced by £5 if I bring my bottle of polish. The price is reduced by 10% if I book and pay for the next 5 appointments in advance and by 15% if I book at least the next 10.
I want to pay for my next 5 cut and blow-dry appointments, as well as for my next 3 manicures.

How much will it cost?
A. £170
B. £255
C. £260
D. £285
E. £305

Question 102:
Alex, Bailey, Charlie, David, Eli, Frankie and Gemma are all members of the same family consisting of three children. Four of them are adults. Alex is a doctor and is David's brother. One of them is married to Eli, and they have two children. Bailey is married to David; Gemma is their child.

Who is Charlie?
A. Alex's nephew
B. Frankie's father
C. Gemma's brother
D. Eli's child
E. Gemma's sister

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Question 103:

At 14:30, three medical students were asked to examine a patient's heart. Having already watched their colleague, the second two students were twice as fast as the first to examine. During the 8 minutes break after the final student had finished, they were told by their consultant that they had taken too long and so should go back and do the examinations again. The second time all the students took half as long as they had taken the first time with the exception of the first student who, instead took the same time as his two colleagues' second attempt.

Assuming there was a one-minute change over time between each student and they were finished by 15:15, how long did the second student take to examine the first time?

A. 3 minutes
B. 4 minutes
C. 6 minutes
D. 7 minutes
E. 8 minutes

Question 104:

I pay for 2 chocolate bars that cost £1.65 each with a £5 note. I receive 8 coins change, only 3 of which are the same.

Which coin do I not receive in my change?

A. 1p
B. 2p
C. 5p
D. 20p
E. 10p

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Question 105:
Two 140m long trains are running at the same speed in opposite directions.

If they cross each other in 14 seconds, then what is speed of each train?
A. 10 km/hr
B. 18 km/hr
C. 32 km/hr
D. 36 km/hr
E. 42 km/hr

Question 106:
Anil has to refill his home's swimming pool. He has four hoses which all run at different speeds. Alone, the first would completely fill the pool with water in 6 hours, the second in two days, the third in three days and the fourth in four days.

Using all the hoses together, how long will it take to fill the pool to the nearest quarter of an hour?
A. 4 hours 15 minutes
B. 4 hours 30 minutes
C. 4 hours 45 minutes
D. 5 hours
E. 5 hours 15 minutes

Question 107:
An ant is stuck in a 30 cm deep ditch. When the ant reaches the top of the ditch, he will be able to climb out straight away. The ant is able to climb 3 cm upwards during the day but falls back 2 cm at night.

How many days does it take for the ant to climb out of the ditch?
A. 27
B. 28
C. 29
D. 30
E. 31

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Question 108:

When buying his ingredients, a chef gets a discount of 10% when he buys 10 or more of each item, and 20% discount when he buys 20 or more. On one order he bought 5 sausages and 10 oranges and paid £8.50. On another, he bought 10 sausages and 10 apples and paid £9, and on a third he bought 30 oranges and paid £12.

How much would an order of 2 oranges, 13 sausages and 12 apples cost?

A. £12.52
B. £12.76
C. £13.52
D. £13.76
E. £13.80

Question 109:

My hairdressers encourage all of its clients to become members. By paying an annual member fee, the cost of haircuts decreases. VIP membership costs £125 annually with a £10 reduction on haircuts. Executive VIP membership costs £200 for the year with a £15 reduction per haircut. At the moment I am not a member and pay £60 per haircut. I know how many haircuts I have a year, and I work out that by becoming a member on either programme it would work out cheaper, and I would save the same amount of money per year on either programme.

How much will I save this year by buying membership?

A. £10
B. £15
C. £25
D. £30
E. £50

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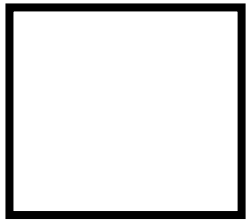
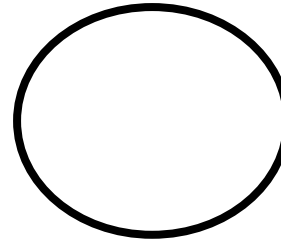
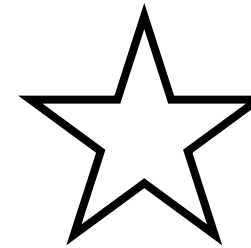
Question 110:
If criminals, thieves and judges are represented below:



Criminals



Thieves



Judges

Assuming that judges cannot be criminals, all thieves are criminals and all those who are guilty are convicted of their crimes, which of one of the following best represents their interaction?

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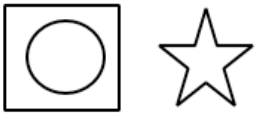
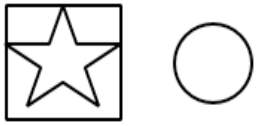
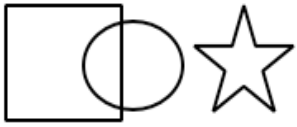
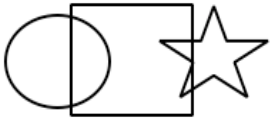
A.

B. 

C. 

D. 

E. 

Question 111:

The months of the year have been made into number codes. The code is comprised of three numbers of one or two digits. Two of these numbers are related to the letters that make up the name of the month. No two months have the same first number. But some such as March, which has the code 3513, have the same last number as others, such as May, which has the code 5313. October would be coded as 10715 while February is 286.

What would be the code for April?

A. 154
B. 441
C. 451
D. 514
E. 541

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Question 112:
A mother gives yearly birthday presents of money to her children based on the age and their exam results. She gives them £5 each, plus £3 for every year they are older than 5, and a further £10 for every A* they achieved in their exams. Josie is 16 and gained 9 A*s in her results. Although Josie's brother Carson is 2 years older, he receives £44 less a year for his birthday.

How many more A*s did Josie get than Carson?
A. 2
B. 3
C. 4
D. 5
E. 10

Question 113:
Apples are more expensive than pears, which are more expensive than oranges. Peaches are more expensive than oranges. Apples are less expensive than grapes.

Which of the following must be true?
A. Grapes are less expensive than oranges.
B. Peaches are more expensive than pears.
C. Grapes are more expensive than pears.
D. Pears and peaches are the same price.
E. Apples and peaches are the same price.

Question 114:
What is the minimum number of straight cutting motions needed to slice a cylindrical cake into 8 equally sized pieces?

A. 2
B. 3
C. 4
D. 5
E. 6

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Question 115

Three friends, Mark, Russell and Tom had agreed to meet for lunch at 12 PM on Sunday. Daylight saving time (GMT+1) had started at 2 AM that same day, where clocks should be put forward by one hour. Mark's phone automatically changes the time, but he does not realise this so when he wakes up, he puts his phone forward an hour and uses his phone to time his arrival to lunch. Tom puts all of his clocks (that don't update automatically) forward one hour at 7 AM. Russell forgets that the clocks should go forward, wakes at 10 AM, and doesn't change his clocks. All of the friends believe they arrive on time.

Assuming that none of the friends realise any errors before arriving, which of the following statements is **FALSE**?

A. Tom arrives at 12 PM (GMT +1).
B. All three friends arrive at the same time.
C. There is a 2-hour difference between when the first and last friend arrive.
D. Mark arrives early.
E. Mark arrives at 1 PM in the timezone GMT+3.

Question 116:

A class of young students has a pet spider. Deciding to play a practical joke on their teacher, one day during morning break one of the students put the spider in their teachers' desk. When first questioned by the head teacher, Mr Jones, the five students who were in the classroom during morning break all lied about what they saw. Realising that the students were all lying, Mr Jones called all 5 students back individually and, threatened with suspension, all the students told the truth. Unfortunately, Mr Jones only wrote down the student's statements, and not which were true and which were lies. The students' two statements appear below:

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Archie:
1. "It wasn't Edward."
2. "It was Bella."

Darcy:
1. "It was Charlotte"
2. "It was Bella"

Edward:
1. "It was Darcy"
2. "It wasn't Archie"

Charlotte:
1. "It was Edward."
2. "It wasn't Archie"

Bella:
1. "It wasn't Charlotte."
2. "It wasn't Edward."

Who put the spider in the teacher's desk?

A. Edward
B. Bella
C. Darcy
D. Charlotte
E. More information needed.

Question 117:

Dr Massey wants to measure out 0.1 litres of solution. Unfortunately, the lab assistant dropped the 200 ml measuring cylinder, and so the scientist only has a 300 ml and a half litre-measuring beaker. Assuming he cannot accurately use the beakers to measure anything less than their full capacity, what is the minimum volume he will have to use to be able to ensure he measures the right amount?

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A. 100 ml
B. 200 ml
C. 300 ml
D. 400 ml
E. 600 ml

Question 118:
Francis lives on a street with houses all consecutively numbered evenly. When one adds up the value of all the house numbers it totals 870.

In order to determine Francis' house number:

1. The relative position of Francis' house must be known.
2. The number of houses in the street must be known.
3. At least three of the house numbers must be known.

Which of the statements are true?
A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 119:
There were 20 people exercising in the cardio room of a gym. Four people were about to leave when suddenly a man collapsed on one of the machines. Fortunately, a doctor was on the machine beside him. Emerging from his office, one of the personal trainers called an ambulance. In the 5 minutes that followed before the two paramedics arrived, half of the people who were leaving, left upon hearing the commotion, and eight people came in from the changing rooms to hear the paramedics pronouncing the man dead.

How many living people were left in the room?

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A. 25
B. 26
C. 27
D. 28
E. 29

Question 120:

A man and woman are in an accident. They both suffer the same trauma, which causes both of them to lose blood at a rate of 0.2 Litres/minute. At normal blood volume, the man has 8 litres and the woman 7 litres, and people collapse when they lose 40% of their normal blood volume.

Which of the following is true?

A. The man will collapse 2 minutes before the woman.
B. The woman collapses 2 minutes before the man.
C. The total blood loss is 5 litres.
D. The woman has 4.8 litres of blood in her body when she collapses.
E. The man's blood loss is 4.8 litres when he collapses.

Question 121:

Jenny, Helen and Rachel have to run a distance of 13 km. Jenny runs at a pace of 8 kmph, Helen at a pace of 10 kmph, and Rachel 11 kmph.

If Jenny sets off 15 minutes before Helen, and 25 minutes before Rachel, what order will they arrive at the destination?

A. Jenny, Helen, Rachel.
B. Helen, Rachel, Jenny.
C. Helen, Jenny, Rachel.
D. Rachel, Helen, Jenny.
E. Jenny, Rachel, Helen.

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Question 122:

On a specific day at a GP surgery 150 people visited the surgery and common complaints were recorded as a percentage of total patients. Each patient could use their appointment to discuss up to 2 complaints. 56% reported flu-like symptoms, 48% pain, 20% diabetes, 40% asthma/COPD and 30% high blood pressure.

Which statement **must** be true?

A. A minimum of 8 patients complained of pain and flu-like symptoms.
B. No more than 45 patients complained of high blood pressure and diabetes.
C. There was a minimum of 21 patients who did not complain about flu-like symptoms or high blood pressure.
D. There were actually 291 patients who visited the surgery.
E. None of the above.

Question 123:

All products in a store were marked up by 15%. They were subsequently reduced in a sale with quoted saving of 25% from the higher price. What is the true reduction from the original price?

A. 5%
B. 10%
C. 13.75%
D. 18.25%
E. 20%

Question 124:

A recipe states it makes 12 pancakes and requires the following ingredients: 2 eggs, 100g plain flour, and 300ml milk. Steve is cooking pancakes for 15 people and wants to have sufficient mixture for 3 pancakes each. However, he knows that the first pancake will go wrong and won't be eaten.

What quantities of each ingredient should Steve use?

A. 2½ eggs, 125g plain flour, 375ml milk
B. 3 eggs, 150g plain flour, 450 ml milk
C. 7½ eggs, 375g plain flour, 1125 ml milk
D. 8 eggs, 400g plain flour, 1200 ml milk
E. 12 eggs, 600g plain flour, 1800 ml milk

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Question 125:
Spring Cleaning cleaners buy industrial bleach from a warehouse and dilute it twice before using it domestically. The first dilution is by 9:1 and then the second, 4:1.

If the cleaners require 6 litres of diluted bleach, how much warehouse bleach do they require?

A. 30 ml
B. 120 ml
C. 166 ml
D. 666 ml
E. 1,200 ml

Question 126:
During a GP consultation in 2015, Ms Smith tells the GP about her grandchildren. Ms Smith states that Charles is the middle grandchild and was born in 2002. She also says that in 2010, Bertie was twice the age of Adam and that in 2015 there are 5 years between Bertie and Adam. Charles and Adam are separated by 3 years.

How old are the 3 grandchildren in 2015?
A. Adam = 16, Bertie = 11, Charles = 13
B. Adam = 5, Bertie = 10, Charles = 8
C. Adam = 10, Bertie = 15, Charles = 13
D. Adam = 10, Bertie = 20, Charles = 13
E. Adam = 11, Bertie = 10, Charles = 8

Question 127:
Kayak Hire charges a fixed flat rate and then an additional half-hourly rate. Peter hires the kayak for 3 hours and pays £14.50, and his friend Kevin hires 2 kayaks for 4hrs30mins each and pays £41.

How much would Tom pay to hire one kayak for 2 hours?

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A. £8
B. £10.50
C. £15
D. £33.20
E. £35.70

Question 128:

A ticketing system uses a common digital display of numbers 0 – 9. The number 7 is showing. However, the light elements used to show it are stuck on and won't turn off.

Which set of the following digits is it possible to display?

A. 3, 4, 7
B. 0, 1, 9
C. 2, 7, 8
D. 0, 5, 9
E. 3, 8, 9

Question 129:

A team of 4 builders take 12 days of 7 hours work to complete a house. The company decides to recruit 3 extra builders. How many 8-hour days will it take the new workforce to build a house?

A. 2 days
B. 6 days
C. 7 days
D. 10 days
E. 12 days

Question 130:

All astragalus are fabacaea as are all gummifer. Acacia are not astragalus.

Which of the following statements is true?

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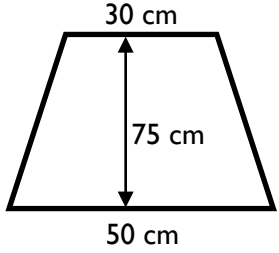
A. Acacia are not fabacaea.
B. No astragalus are also gummifer.
C. All fabacae are astragalus or gummifer.
D. Some acacia may be fabacaea.
E. Gummifer are all acacia.

Question 131:

The Smiths want to reupholster both sides of their seating cushions (dimensions shown on diagram). The fabric they are using costs £10/m, can only be bought in whole metre lengths and has a standard width of 1m. Each side of a cushion must be made from a single piece of fabric. The seamstress changes a flat rate of £25 per cushion.

How much will it cost them to reupholster 4 cushions?

A. £ 20
B. £ 80
C. £ 110
D. £ 130
E. £ 150



Negligible Thickness

Question 132:

Lisa buys a cappuccino from either Milk or Beans Coffee shops each day. The quality of the coffee is the same, but she wishes to work out the relative costs once the loyalty scheme has been considered. In Milk, a regular cappuccino is £2.40, and in Beans, £2.15. However, the loyalty scheme in Milk gives Lisa a free cappuccino for every 9 she buys, whereas Beans use a points system of 10 points per full pound spent (each point is worth 1p) which can be used to cover the cost of a full cappuccino.

If Lisa buys a cappuccino each day of September, which coffee shop would work out cheaper, and by how much?

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A. Milk, by £4.60
B. Beans by £6.30
C. Beans, by £4.60
D. Beans, by £2.45
E. Milk, by £2.45

Question 133:
Paula needs to be at a meeting in Notting Hill at 11am. The route requires her to walk 5 minutes to the 283 bus which takes 25 minutes, and then change to the 220 bus which takes 14 minutes. Finally, she walks for 3 minutes to her meeting.

If the 283 bus comes every 10 minutes, and the 220 bus at 0 minutes, 20 minutes and 40 minutes past the hour, what is the latest time she can leave and still be at her meeting on time?
A. 09.45
B. 09.58
C. 10.01
D. 10.05
E. 10.10

Question 134:
Two trains, a high-speed train A and a slower local train B, travel from Manchester to London. Train A travels the first 20 km at 100 km/hr and then at an average speed of 150km/hr. Train B travels at a constant average speed of 90 km/hr.

If train B leaves 20 minutes before train A, at what distance will train A pass train B?
A. 75 km
B. 90 km
C. 100 km
D. 120 km
E. 150 km

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Question 135:

The university gym has an upfront cost of £35 with no contract fee, but classes are charged at £3 each. The local gym has no joining fee and is £15 per month.

What is the minimum number of classes I need to attend in a 12-month period to make the local gym cheaper than the university gym?

A. 40
B. 48
C. 49
D. 50
E. 55

Question 136:

"All medicines are drugs, but not all drugs are medicines", goes a well-known saying. If we accept this statement as true, and consider that all antibiotics are medicines, but no herbal drugs are medicines, then which of the following is definitely **FALSE**?

A. Some herbal drugs are not medicines.
B. All antibiotics are drugs.
C. Some herbal drugs are antibiotics.
D. Some medicines are antibiotics
E. None of the above

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Question 137:

Sonia has been studying the paths taken by various trains travelling between London and Edinburgh on the East coast. Trains can stop at the following stations: Newark, Peterborough, Doncaster, York, Northallerton, Darlington, Durham and Newcastle.

She notes the following:

- All trains stop at Peterborough, York, Darlington and Newcastle.
- All trains which stop at Northallerton also stop at Durham.
- Each day, 50% of the trains stop at both Newark *and* Northallerton.
- All designated "fast" trains make less than 5 stops. All other trains make 5 stops or more.
- On average, 16 trains run each day.

Which of the following can be reliably concluded from these observations?

A. All trains, which are not designated "fast" trains, must stop at Durham.
B. No more than 8 trains on any 1 day will stop at Northallerton.
C. No designated "fast" trains will stop at Durham.
D. It is possible for a train to make 5 stops, including Northallerton.
E. A train which stops at Newark will also stop at Durham.

Question 138:

Rakton is 5 miles directly north of Blueville. Gallford is 8 miles directly south of Haston. Lepstone is situated 5 miles directly east of Blueville, and 5 miles directly west of Gallford.

Which of the following **CANNOT** be reliably concluded from this information?

A. Lepstone is South of Rakton.
B. Haston is North of Rakton.
C. Gallford is East of Rakton.
D. Blueville is East of Haston.
E. Haston is North of Lepstone.

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Question 139:

The Eastminster Parliament is undergoing a new set of elections. There are 600 seats up for election, each of which will be elected separately by the people living in that constituency. 6 parties: the Blue Party, the Red party, the Orange party, the Yellow party, the Green party and the Purple party, win at least 1 seat in the election. In order to form a government, a party (or coalition) must hold *over* 50% of the seats. After the election, a political analysis committee produces the following report:

- No party has gained more than 45% of the seats, so nobody is able to form a government by themselves.
- The Red and the Blue party each gained over 40% of the seats.
- No other party gained more than 4% of the seats.
- The Yellow party did not win the fewest seats

The Red party work out that if they collaborate with the Green party and the Orange party, between the 3 of them, they will have enough seats to form a coalition government.

What is the minimum number of seats that the green party could have?

A. 5
B. 6
C. 13
D. 14
E. 23

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Questions 140-144 are based on the following information:

A grandmother wants to give her five grandchildren £100 between them for Christmas this year. She wants to grade the money she gives to each grandchild so that the older children receive more than the younger ones. She wants to share the money so she will give the 2nd youngest child as much more than the youngest, as the 3rd youngest gets than the 2nd youngest, as the 4th youngest gets from the 3rd youngest and so on. The result will be that the two youngest children together will get seven times as less money than the three oldest.

M is the amount of money the youngest child receives, and D the difference between the amount the youngest and 2nd youngest children receive.

Question 140:

What is the expression for the amount the oldest child receives?

A. M
B. M + D
C. 2M
D. $4M^2$
E. M + 4D

Question 141:

What is the correct expression for the total money received?

A. 5M = £100
B. 5D + 10M = £100
C. $D = \frac{M}{100}$
D. 5M + 10D = £100
E. $M = \frac{2D}{11}$

Question 142:

"*The two youngest children together will get seven times less money than the three oldest.*"

Which one of the following best expresses the above statement?

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A. $7(3M + 9D) = 2M + D$

$7D = M$

B. $7(2M + D) = 3M + 9D$

C. $2(7M + D) = 3M + 9D$

D. $2(7D+M) = 3M + 9D$

Question 143

Using the statement in the previous question, what is the correct expression for *M*?

A. $\frac{2D}{11}$

B. $\frac{2}{11}$

C. $\frac{10D}{11}$

D. $\frac{120}{11}$

E. 2.5D

Question 144:

Express £100 in terms of D.

A. $£\ 100 = \frac{120D}{11}$

B. $£\ 100 = \frac{120D}{10}$

C. $£\ 100 = \frac{120}{11D}$

D. $£\ 100 = 21D$

E. $£\ 100 = 5M + 10D$

Question 145:

Four girls entered a local baking competition. Though a bit burnt, Ellen's carrot cake did not come last. The girl who baked a Madeira sponge had practiced a lot, and so came first, while Jaya came third with her entry. Aleena did better than the girl who made the tiramisu, and the girl who made the Victoria sponge did better than Veronica.

Which of the following was **NOT** a result of the competition?

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A. Veronica made a tiramisu.
B. Ellen came second.
C. Aleena did not make a Victoria sponge.
D. The Victoria sponge came in 3rd place.
E. The carrot cake came 3rd.

Question 146:

In a children's football league, the 5 teams were: the Celtic Changers, Eire Lions, Nordic Nesters, Sorten Swipers and the Whistling Winners. One of the boys playing in the league, after being asked by his parents, said that while he could remember the other teams' total points, he could not remember his own team's – the Eire Lions – score. He said that all the teams played each other and when teams lost, they were given 0 points, and when they drew, 1 point. 3 points were given for a win. He remembered that the Celtic Changers had a total of 2 points; the Sorten Swipers had 5; the Nordic Nesters had 8, and the Whistling Winners 1.

How many did the boys' team score?

A. 1
B. 4
C. 8
D. 10
E. 11

Question 147:

T is the son of Z, Z and J are sisters, R is the mother of J and S is the son of R.

Which one of the following statements is correct?

A. T and J are cousins
B. S and J are sisters
C. J is the maternal uncle of T
D. S is the maternal uncle of T
E. R is the grandmother of Z.

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Question 148:

John likes to shoot bottles off a shelf. In the first round he places 16 bottles on the shelf and knocks off 8 bottles. 3 of the knocked off bottles are damaged and can no longer be used, whilst 1 bottle is lost. He puts the undamaged bottles back on the shelf before continuing. In the second round he shoots six times and misses 50% of these shots. He damages two bottles with every shot which does not miss. 2 bottles also fall off the shelf at the end. He puts up 2 new bottles before continuing. In the final round, John misses all his shots and in frustration, knocks over gets angry and knocks over 50% of the remaining bottles.

How many bottles were left on the wall after the final round?

A. 2
B. 3
C. 4
D. 5
E. 6

Questions 149 - 155 are based on the information below:

All lines are named after a station they serve, apart from the Oval and Rectangle lines, which are named for their recognisable shapes. Trains run in both directions.

- There are express trains that run from end to end of the St Mark's and Straightly lines in 5 and 6 minutes respectively.
- It takes 2 minutes to change between St Mark's and both Oval and Rectangle lines, but only 1 minute between Rectangle and Oval.
- It takes 3 minutes to change between the Straightly and all other lines, except with the St Mark's line which only takes 30 seconds.
- The Straightly line is a fast line and takes only 2 minutes between stops apart from to and from Keyton, which only takes 1 minute, and to and from Lime St, which takes 3 minutes.
- The Oval line is much slower and takes 4 minutes between stops, apart from between Baxton and Marven, and also Archite and West Quays, which takes 5 minutes.
- The Rectangle line is also called the reliable line – it never runs late. However, as a consequence it is much slower, taking 6 minutes between stops.
- The St Mark's line is fast and takes 2 and half minutes between stations.

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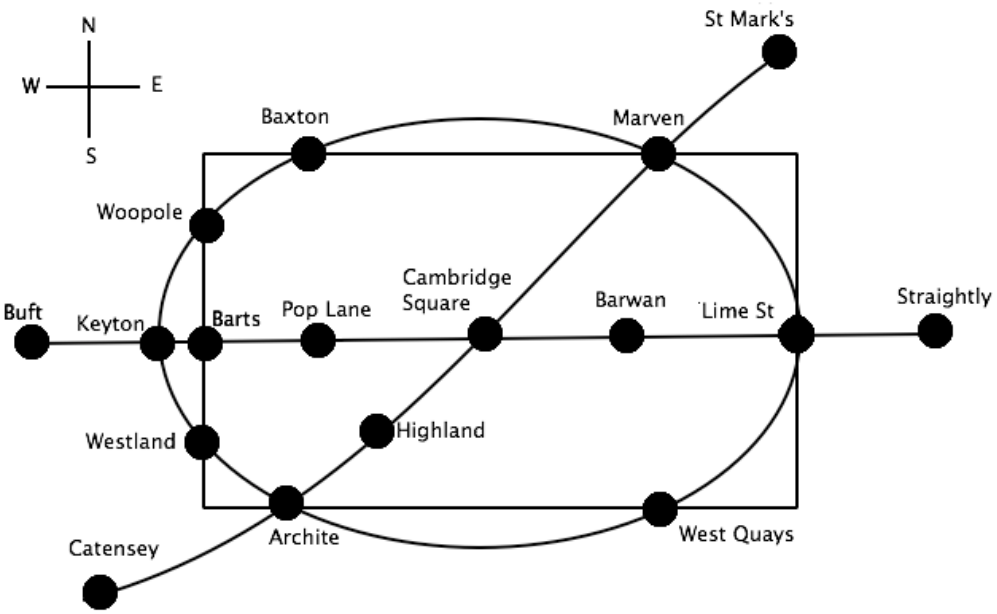
- If a passenger reaches the end of the line, it takes three minutes to change onto a train travelling back in the opposite direction.



Question 149:

Assuming all lines are running on time, how long does it take to go from St Mark's to Archite on the St Mark's line?

A. 5 minutes
B. 6 minutes
C. 7.5 minutes
D. 10 minutes
E. 12.5 minutes

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Question 150:

Assuming all lines are running on time, what's the shortest time it will take to go from Buft to Straightly?

A. 6 minutes
B. 10 minutes
C. 12 minutes
D. 14 minutes
E. 16 minutes

Question 151:

What is the shortest time it will take to go from Baxton to Pop Lane?

A. 11 minutes
B. 12 minutes
C. 13 minutes
D. 14 minutes
E. 15 minutes

Question 152

Which station, even at the quickest journey time, is furthest in terms of time from Cambridge Square?

A. Catensey
B. Buft
C. Woopole
D. Westland
E. Straightly

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Questions 153-155 use this additional information:
On a difficult day there are signal problems whereby all lines except the reliable line are delayed, such that train travel times between stations are doubled. These delays have caused overcrowding at the platforms which means that while changeover times between lines are still the same, passengers always have to wait an extra 5 minutes on all of the platforms before catching the next train.

Question 153
At best, how long will it now take to go from Westland to Marven?

A. 25 minutes
B. 29 minutes
C. 30 minutes
D. 33 minutes
E. 35 minutes

Question 154:
There is a bus that goes from Baxton to Archite and takes 27-31 minutes. Susan lives in Baxton and needs to get to her office in Archite as quickly as possible.

With all the delays and lines out of service, how should you advise Susan best to get to work?
A. Baxton to Archite via Barts using the Rectangle line.
B. Baxton to Woopole on the Rectangle line, then Oval to Archite via Keyton.
C. It is not possible to tell between the fastest two options.
D. Baxton to Woopole on the Rectangle line, then Oval to Archite via Keyton.
E. Baxton to Archite on the Oval line.

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Question 155:
In addition to the delays the Oval line signals fail completely, so the line falls out of service. How long will it now take to go from St Mark's to West Quays as quickly as possible?

A. 35 minutes
B. 30 minutes
C. 33 minutes
D. 29 minutes
E. 30.5 minutes

Question 156:
In an unusual horserace, only 4 horses, each with different racing colours and numbers, competed. Simon's horse wore number 1. Lila's horse wasn't painted yellow or blue, and the horse that wore 3, which was wearing red, beat the horse that came in third. Only one horse wore the same number as the position it finished in. Arthur's horse beat Simon's horse, whereas Celia's horse beat the horse that wore number 1. The horse wearing green, Celia's, came second, and the horse wearing blue wore number 4.

Which one of the following must be true?

A. Simon's horse was yellow and placed 3rd.
B. Celia's horse was red.
C. Celia's horse was in third place.
D. Arthur's horse was blue.
E. Lila's horse wore number 4.

Question 157:
Jessie plants a tree with a height of 40 cm. The information leaflet states that the plant should grow by 20% each year for the first 2 years, and then 10% each year thereafter.

What is the expected height at 4 years?

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A. 58.08 cm
B. 64.89 cm
C. 69.696 cm
D. 89.696 cm
E. 82.944 cm

Question 158

A company is required to pay each employee 10% of their wage into a pension fund if their annual total wage bill is above £200,000. However, there is a legal loophole that if the company splits over two sites, the £200,000 bill is per site. The company therefore decides to have an east site, and a west site to save money on pension contributions for its staff.

Name	Annual Salary (£)
Luke	47,000
John	78,400
Emma	68,250
Nicola	88,500
Victoria	52,500
Daniel	63,000

Which employees should be grouped at the same site to minimise pension costs?

A. John, Nicola, Luke
B. Nicola, Victoria, Daniel
C. Nicola, Daniel, Luke
D. John, Daniel, Emma
E. Luke, Victoria, Emma

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Question 159:

A bus takes 24 minutes to travel from White City to Hammersmith with no stops. Each time the bus stops to pick up and/or drop off passengers, it takes approximately 90 seconds. This morning, the bus picked up passengers from 5 stops, and dropped off passengers at 7 stops.

What is the minimum journey time from White City to Hammersmith this morning?

A. 28 minutes
B. 34 minutes
C. 34.5 minutes
D. 36 minutes
E. 37.5 minutes

Question 160:

Sally is making a Sunday roast for her family and is planning her schedule regarding cooking times. The chicken takes 15 minutes to prepare, 75 minutes to cook, and needs to stand for exactly 5 minutes after cooking. The potatoes take 18 minutes to prepare, 5 minutes to boil and then 50 minutes to roast. They must be roasted immediately after boiling, and then served immediately. The vegetables require only 5 minutes preparation time and 8 minutes boiling time before serving and can be kept warm to be served at any time after cooking. The cooker can only be cooking two items at any given time and Sally can prepare only one item at a time. She also wants to start cooking each item as late as possible.

What time should Sally start cooking each item, so dinner is served at 4:00 pm?

A. Chicken 2:25, potatoes 2:47, vegetables 2:42
B. Chicken 2:25, potatoes 2:47, vegetables 3:47
C. Chicken 2:35, potatoes 3:47, vegetables 2:47
D. Chicken 2:35, potatoes 2:47, vegetables 3:47
E. Chicken 2:45, potatoes 3:47, vegetables 2:47

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Question 161:

The Smiths have 4 children whose total age is 80. Paul is double the age of Jeremy. Annie is exactly halfway between the ages of Jeremy and Paul, and Rebecca is 2 years older than Paul.

How old are each of the children?

A. Paul 23, Jeremy 12, Rebecca 26, Annie 19.
B. Paul 22, Jeremy, 11, Rebecca 24, Annie 16.
C. Paul 24, Jeremy 12, Rebecca 26, Annie 18.
D. Paul 28, Jeremy 14, Rebecca 30, Annie 21.
E. More information needed.

Question 162:

Sarah has a jar of spare buttons that are a mix of colours and sizes. The jar contains the following mix of buttons:

	10mm	25mm	40mm
Cream	15	22	13
Red	6	15	7
Green	9	19	8
Blue	20	6	15
Yellow	4	8	26
Black	17	16	14
Total	**71**	**86**	**83**

Sarah wants to use a 25mm diameter button but doesn't mind if it is cream or yellow. What is the maximum number of buttons she will have to remove in order to guarantee to pick a suitable button on the next attempt?

A. 210
B. 218
C. 219
D. 239
E. None of these

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Question 163:

Ben wants to optimise his score with one throw of a dart. 50% of the time, he hits a segment to either side of the one he is aiming at. With this in mind, which segment should he aim for? (Ignore all double/triple modifiers)

A. 15
B. 16
C. 17
D. 18
E. 19

Question 164:

Victoria is completing her weekly shop, and the total cost of the items is £8.65. She looks in her purse and sees that she has a £5 note and a large amount of change, including all types of coins. She uses the £5 note, and pays the remainder using the maximum number of coins possible in order to remove some weight from the purse.

However, the store has certain rules she has to follow when paying:

- No more than 20p can be paid in "bronze" change (the name given to any combination of 1p pieces and 2p pieces)
- No more than 50p can be paid using any combination of 5p pieces and 10p pieces.
- No more than £1.50 can be paid using any combination of 20p pieces and 50p pieces.

Victoria pays the exact amount and does not receive any change. Under these rules, what is the *maximum* number of coins that Victoria can have paid with?

A. 30
B. 31
C. 36
D. 41
E. 46

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Question 165:

I look at the clock on my bedside table, and I see the following digits:

However, I also see that there is a glass of water between me and the clock, which is in front of 2 adjacent figures. I know that this means these 2 figures will appear reversed. For example, 10 would appear as 01, and 20 would appear as 05 (as 5 on a digital clock is a reversed image of a 2). Some numbers, such as 3, cannot appear reversed because there are no numbers which look like the reverse of 3.

Which of the following could be the actual time?

A. 15:52
B. 21:25
C. 12:55
D. 12:22
E. 21:52

Question 166:

Slavica has invaded Worsid, whilst Nordic has invaded Lorkdon. Worsid, spotting an opportunity to bolster its amount of land and natural resources, invades Nordic. Each of these countries is either a dictatorship or a democracy. Slavica is a dictatorship, but Lorkdon is a democracy. 10 years ago, a treaty was signed which guaranteed that no democracy would invade another democracy. No dictatorship has both invaded another dictatorship *and* been invaded by another dictatorship.

Which one of these statements is true?

A. Worsid is a Dictatorship.
B. Worsid is a Democracy.
C. Worsid does not practice either of these forms of government.
D. It is impossible to tell.
E. Worsid could be a combination of dictatorship and democracy.

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Question 167:

Sheila is on a shift at the local supermarket. Unfortunately, the till has developed a fault, meaning it cannot tell her how much change to give each customer. A customer is purchasing the following items, at the following costs:

- A packet of grated cheese priced at £3.25
- A whole cucumber priced at 75p
- A fish pie mix priced at £4.00
- 3 DVDs priced at £3.00 each

Sheila knows there is an offer on DVDs in the store at present, in which 3 DVDs bought together will only cost £8.00. The customer pays with a £50 note.

How much change will Sheila need to give the customer?

A. £4
B. £33
C. £34
D. £36
E. £38

Question 168:

Ryan is cooking breakfast for several guests at his hotel. He is frying most of the items using the same large frying pan, to get as much food prepared in as little time as possible. Ryan is cooking bacon, sausages, and eggs in this pan. He calculates how much room is taken up in the pan by each item. He calculates the following:

- Each rasher of bacon takes up 7% of the available space in the pan
- Each sausage takes up 3% of the available space in the pan.
- Each egg takes up 12% of the available space in the pan.

Ryan is cooking 2 rashers of bacon, 4 sausages and 1 egg for each guest. He decides to cook all the food for each guest at the same time, rather than cooking all of each item at once.

How many guests can he cook for at once?

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A. 1
B. 2
C. 3
D. 4
E. 5

Question 169:

SafeEat Inc. is a national food development testing agency. The Manchester-based laboratory has a system for recording all the laboratory employees' birthdays, and presenting them with cake on their birthday, in order to keep staff morale high. Certain amounts of petty cash are set aside each month in order to fund this. 40% of the staff have their birthday in March, and the secretary works out that £60 is required to fund the birthday cake scheme during this month.

If all birthdays cost £2 to provide a cake for, how many people work at the laboratory?

A. 45
B. 60
C. 75
D. 100
E. 150

Question 170:

Many diseases, such as cancer, require specialist treatment, and thus cannot be treated by a general practitioner. Instead, these diseases must be referred to a specialist after an initial, more generalised, medical assessment. Bob had a biopsy on the 1st of August on a lump found in his abdomen. The results show that it is a tumour, with a slight chance of becoming metastatic, so he is referred to a waiting list for specialist radiotherapy and chemotherapy. The average waiting time in the UK for such treatment is 3 weeks, but in Bob's local district, high demand means that it takes 50% longer for each patient to receive treatment. As he is a lower risk case, with a low risk of metastasis, his waiting time is extended by another 20%.

How many weeks will it be before Bob receives specialist treatment?

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A. 4.5
B. 4.6
C. 5.0
D. 5.1
E. 5.4

Question 171:

In a class of 30 seventeen-year-old students, 40% drink alcohol at least once a month. Of those who drink alcohol at least once a month, 75% drink alcohol at least once a week. 1 in 3 of the students who drink alcohol at least once a week also smoke marijuana. 1 in 3 of the students who drink alcohol less than once a month also smoke marijuana.

How many of the students in total smoke marijuana?

A. 3
B. 4
C. 6
D. 9
E. 10

Question 172:

Complete the following sequence of numbers: 1, 4, 10, 22, 46, …

A. 84
B. 92
C. 94
D. 96
E. 100

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Question 173:

If the mean of 5 numbers is 7, the median is 8 and the mode is 3, what must the two largest numbers in the set of numbers add up to?

A. 14
B. 21
C. 24
D. 26
E. 35

Question 174:

Ahmed buys a 1kg bag of potatoes from the supermarket each week. 1kg bags have to weigh between 900 and 1100 grams. In the first week, there are 10 potatoes in the bag. The next week, there are only 5.

Assuming that the potatoes in the bag in week 1 are all the same weight as each other, and the potatoes in the bag in week 2 are all the same weight as each other, what is the maximum possible difference between the heaviest and lightest potato in the two bags?

A. 50g
B. 70g
C. 90g
D. 110g
E. 130g

Question 175:

A football tournament involves a group stage, then a knockout stage. In the group stage, groups of four teams play in a round robin format (i.e. each team plays every other team once) and the team that wins the most matches in each group proceeds through to a knockout stage. In addition, the single best performing second place team across all the groups gains a place in the knockout stage. In the knockout stage, sets of two teams play each other and the one that wins proceeds to the next round until there are two teams left, who play each other in the final.

If we start with 60 teams, how many matches are played altogether?

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A. 75
B. 90
C. 100
D. 105
E. 165

Question 176:
The last 4 digits of my card number are 2 times my PIN number, plus 200. The last 4 digits of my husband's card number are the last four digits of my card number doubled, plus 200. My husband's PIN number is 2 times the last 4 digits of his card number, plus 200.

Given that all these numbers are 4 digits long, whole numbers, and cannot begin with 0, what is the largest number my PIN number can be?
A. 1,074
B. 1,174
C. 2,348
D. 4,096
E. 9,999

Question 177:
All women between 50 and 70 in the UK are invited for breast cancer screening every 3 years. Patients at Doddinghurst Surgery are invited for screening for the first time at any point between their 50th and 53rd birthday. If they ignore an invitation, they are sent reminders every 5 months. We can assume that a woman is screened exactly 1 month after she is sent the invitation or reminder that she accepts. The next invitation for screening is sent exactly 3 years after the previous screening.

If a woman accepts the screening on the second reminder each time, what is the youngest she can be when she has her 4th screening?

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A. 60
B. 61
C. 62
D. 63
E. 64

Question 178:

Ellie gets a pay rise of *k* thousand pounds on every anniversary of joining the company, where *k* is the number of years she has been at the company. She currently earns £40,000, and she has been at the company for 5.5 years.

What was her salary when she started at the company?

A. £25,000
B. £27,000
C. £28,000
D. £30,000
E. £31,000

Question 179:

Northern Line trains arrive into Kings Cross station every 8 minutes, Piccadilly Line trains every 5 minutes and Victoria Line trains every 2 minutes.

If trains from all 3 lines arrived into the station at the same time exactly 15 minutes ago, how long will it be before they do so again?

A. 24 minutes
B. 25 minutes
C. 40 minutes
D. 60 minutes
E. 65 minutes

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Question 180:

If you do not smoke or drink alcohol, your risk of getting Disease X is 1 in 12. If you smoke, you are half as likely to get Disease X as someone who does not smoke. If you drink alcohol, you are twice as likely to get Disease X. A new drug is released that halves anyone's total risk of getting Disease X for each tablet taken.

How many tablets of the drug would someone who drinks alcohol have to take to reduce their risk to the same level as someone who smoked but did not take the drug?

A. 0
B. 1
C. 2
D. 3
E. 4

Questions 181 – 183 refer to the following information:

There are 20 balls in a bag. 1/2 are red. 1/10 of those that are not red are yellow. The rest are green except 1, which is blue.

Question 181:

If I draw 2 balls from the bag (without replacement), what is the most likely combination to draw?

A. Red and green
B. Red and yellow
C. Red and red
D. Blue & yellow
E. Blue and Red

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Question 182:

If I draw 2 balls from the bag (without replacement), what is the least likely (without being impossible) combination to draw?

A. Blue and green
B. Blue & yellow
C. Yellow & yellow
D. Yellow & green
E. Red and green

Question 183:

How many balls do you have to draw (without replacement) to guarantee getting at least one of at least three different colours?

A. 5
B. 12
C. 17
D. 18
E. 19

Question 184:

A general election in the UK resulted in a hung parliament, with no single party gaining more than 50% of the seats. Thus, the main political parties are engaged in discussion over the formation of a coalition government. The results of this election are shown below:

Political Party	Seats won
Conservatives	260
Labour	270
Liberal Democrats	50
UKIP	35
Green Party	20
Scottish National Party	17
Plaid Cymru	13
Sinn Fein	9
Democratic Unionist Party (DUP)	11
Other (14 other parties won 1 seat each)	14

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There is a total of 699 seats, meaning that in order to form a government, any coalition must have at least 350 seats between them. Several of the party leaders have released statements about who they are and are not willing to form a coalition with, which are summarised as follows:

- The Conservative party and Labour are not willing to take part in a coalition together.
- The Liberal Democrats refuse to take part in any coalition which also involves UKIP.
- The Labour party will only form a coalition with UKIP if the Green party are also part of this coalition.
- The Conservative party are not willing to take part in any coalition with UKIP unless the Liberal Democrats are also involved.

Considering this information, what is the minimum number of parties required to form a coalition government?

A. 2
B. 3
C. 4
D. 5
E. 6

Question 185:

On Tuesday, 360 patients attend appointments at Doddinghurst Surgery. Of the appointments that are booked in, only 90% are attended. Of the appointments that are booked in, 1 in 2 are for male patients and the remaining appointments are for female patients. Male patients are three times as likely to miss their booked appointment as female patients.

How many male patients attend appointments at Doddinghurst Surgery on Tuesday?

A. 30
B. 60
C. 130
D. 150
E. 170

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Question 186:

Every A Level student at Greentown Sixth Form studies Maths. Additionally, 60% study Biology, 50% study Economics and 50% study Chemistry. The other subject on offer at Greentown Sixth Form is Physics.

Assuming every student studies 3 subjects and that there are 60 students altogether, how many students study Physics?

A. 15
B. 24
C. 30
D. 40
E. 60

Question 187:

100,000 people are diagnosed with chlamydia each year in the UK. An average of 0.6 sexual partners are informed per diagnosis. Of these, 80% have tests for chlamydia themselves. Half of these tests come back positive.

Assuming that each of the people diagnosed has had an average of 3 sexual partners (none of them share sexual partners or have sex with each other) and that the likelihood of having chlamydia is the same for those partners who are tested and those who are not, how many of the sexual partners who were not tested (whether they were informed or not) have chlamydia?

A. 120,000
B. 126,000
C. 136,000
D. 150,000
E. 240,000

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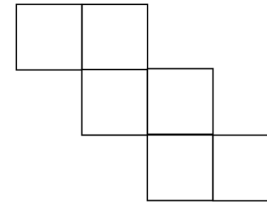
Question 188:

In how many different positions can you place an additional tile to make a straight line of 3 tiles?



A. 6
B. 7
C. 8
D. 9
E. 10

Question 189:

Harry is making orange squash for his daughter's birthday party. He wants to have a 200ml glass of squash for each of the 20 children attending and a 300ml glass of squash for him and each of 3 parents who are helping him out. He has 1,040ml of the concentrated squash.

What ratio of water: concentrated squash should he use in the dilution to ensure he has the right amount to go around?

A. 2:1
B. 3:1
C. 4:1
D. 5:1
E. 6:1

Question 190:

4 children: Alex, Beth, Cathy and Daniel are each sitting on one of the 4 swings in the park. The swings are in a straight line. One possible arrangement of the children is, left to right, Alex, Beth, Cathy, Daniel.

How many other possible arrangements are there?

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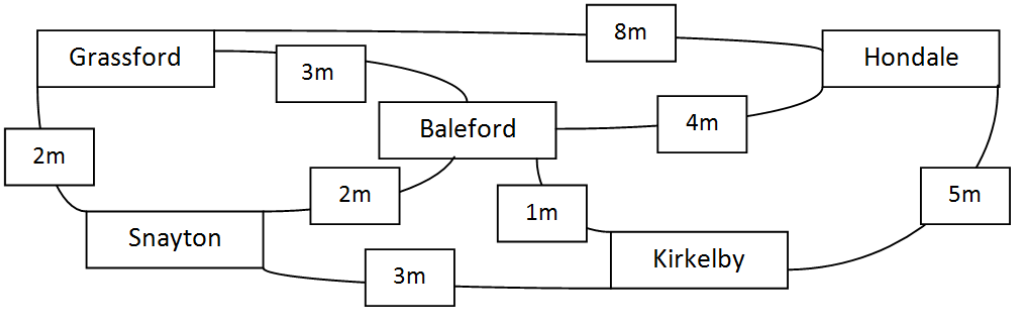
A. 5
B. 12
C. 23
D. 24
E. 64

Question 191:

A delivery driver is looking to make deliveries in several towns. He is given the following map of the towns in the area. The lines indicate roads between the towns, along with the lengths of these roads.

(m here refers to miles)



The delivery driver's vehicle has a black box which records the distance travelled and locations visited. At the end of the day, the black box recording shows that he has travelled a total of 14 miles. It also shows that he has visited one town twice, but has not visited any other town more than once.

Which of the following is a possible route the driver could have taken?

A. Snayton → Baleford→ Grassford → Snayton→ Kirkelby
B. Baleford → Kirkelby→ Hondale → Grassford→ Baleford→ Snayton
C. Kirkelby → Hondale→ Baleford →Grassford→ Snayton
D. Baleford → Hondale→ Grassford → Baleford→ Hondale→ Kirkelby
E. None of the above.

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Question 192:

Ellie, her brother Tom, her sister Georgia, her mum, and her dad line up in height order from shortest to tallest for a family photograph. Ellie is shorter than her dad but taller than her mum. Georgia is shorter than both her parents. Tom is taller than both his parents

If 1 is shortest and 5 is tallest, what position is Ellie in the line?

A. 1
B. 2
C. 3
D. 4
E. 5

Question 193:

Miss Briggs is trying to arrange the 5 students in her class into a seating plan. Ashley must sit on the front row because she has poor eyesight. Danielle disrupts anyone she sits next to apart from Caitlin, so she must sit next to Caitlin and no-one else. Bella needs to have a teaching assistant sat next to her. The teaching assistant must be sat on the left-hand side of the row, near to the teacher. Emily does not get on with Bella, so they need to be sat apart from one another. The teacher has 2 tables which each sit 3 people, which are arranged 1 behind the other.

Who is sitting in the front right seat?

A. Ashley
B. Bella
C. Caitlin
D. Danielle
E. Emily

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Question 194:

My aunt runs the dishwasher twice a week, plus an extra time for each person who is living in the house that week. When her son is away at university, she buys a new pack of dishwasher tablets every 6 weeks, but when her son is home, she has to buy a new one every 5 weeks.

How many people are living in the house when her son is home?

A. 2
B. 3
C. 4
D. 5
E. 6

Question 195:

Dates can be written in an 8-digit form, for example 26-12-2014. How many days after 26-12-2014 would be the next time that the 8 digits were made up of exactly 4 different integers?

A. 6
B. 8
C. 10
D. 16
E. 24

Question 196:

Redtown is 4 miles east of Greentown. Bluetown is 5 miles north of Greentown. If every town is due north, south, east or west of at least two other towns, and the only other town is Yellowtown, how many miles away from Yellowtown is Redtown, and in what direction?

A. 4 miles east of Yellowtown.
B. 5 miles south of Yellowtown.
C. 5 miles north of Yellowtown.
D. 4 miles west of Yellowtown.
E. 5 miles west of Yellowtown.

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Question 197:

Jenna pours wine from two 750ml bottles into glasses. The glasses hold 250ml, but she only fills them to 4/5 of capacity, except the last glass, where she puts whatever she has left.

How full is the last glass compared to its capacity?

A. 1/5
B. 2/5
C. 3/5
D. 4/5
E. 5/5

Question 198:

There are 30 children in Miss Ellis's class. Two thirds of the girls in Miss Ellis's class have brown eyes, and two thirds of the class as a whole have brown hair.

Given that the class is half boys and half girls, what is the difference between the minimum and maximum number of girls that could have brown eyes and brown hair?

A. 0
B. 2
C. 5
D. 7
E. 10

Question 199:

A biased die with the numbers 1 to 6 on it is rolled twice. The resulting numbers are multiplied together, and then their sum subtracted from this result to get the 'score' of the dice roll.

If the probability of getting a negative (non-zero) score is 0.75, what is the probability of rolling a 1 on a third throw of the die?

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A. 0.1
B. 0.2
C. 0.3
D. 0.4
E. 0.5

Questions 200 - 202 are based on the following information:
Fares on the number 11 bus are charged at a number of pence per stop that you travel, plus a flat rate. Emma, who is 21, travels 15 stops and pays £1.70. Charlie, who is 43, travels 8 stops and pays £1.14. Children (under 16) pay half the adult flat rate plus a quarter of the adult charge "per stop".

Question 200:
How much does 17-year-old Megan pay to travel 30 stops to college?
A. £0.85
B. £2.40
C. £2.90
D. £3.40
E. £3.80.

Question 201:
How much does 14-year-old Alice pay to travel 25 stops to school?
A. £0.50
B. £0.75
C. £1.25
D. £2.50
E. £2.70

Question 202:
James, who is 24, wants to get the bus into town. The town stop is the 25th stop along a straight road from his house, but he only has £2.

Assuming he has to walk past the stop nearest his house, how many stops will he need to walk past before he gets to the stop he can afford to catch the bus from?

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A. 4
B. 6
C. 7
D. 8
E. 9

Questions 203 -205 are based on the following information:

Emma mounts and frames paintings. Each painting needs a mount which is 2 inches bigger in each dimension than the painting, and a wooden frame which is 1 inch bigger in each dimension than the mount. Mounts are priced by multiplying 50p by the largest dimension of the mount, so a mount which is 8 inches in one direction and 6 in the other would be £4. Frames are priced by multiplying £2 by the smallest dimension of the frame, so a frame which is 8 inches in one direction and 6 in the other would be £12.

Question 203:

How much would mounting and framing a painting that is 10 x 14 inches cost?

A. £8
B. £26
C. £27
D. £34
E. £42

Question 204:

How much more would mounting and framing a 10 x 10 inch painting cost than mounting and framing an 8 x 8 inch painting?

A. £ 3.00
B. £ 4.00
C. £ 5.00
D. £ 6.00
E. £ 7.00

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Question 205:

What is the largest square painting that can be framed for £40?

A. 12 inches
B. 13 inches
C. 14 inches
D. 15 inches
E. 16 inches

Question 206:

The word 'CREATURES' is coded as 'FTEAWUTEV', which itself is coded as 'HWEAYUWEX'. What would be the second coding of the word 'MAGICAL'?

A. QCKIGAN
B. OCIIEAN
C. PAJIFAN
D. RALIHAQ
E. RCIMGEP

Question 207:

Jane's mum has asked Jane to go to the shops to get some items that they need. She tells Jane that she will pay her per kilometre that she cycles on her bike to get to the shop, plus a flat rate payment for each place she goes to. Jane receives £6 to go to the grocers, a distance of 5 km, and £4.20 to go the supermarket, a distance of 3km.

How much would she earn if she then cycles to the library to change some books, a distance of 7 km?

A. £7.50
B. £7.70
C. £7.80
D. £8.00
E. £8.10

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Question 208:

In 2001-2002, 1,019 patients were admitted to hospital due to obesity. This figure was more than 11 times higher than 2011-12 when there were 11,736 patients admitted to hospital with the primary reason for admission being obesity.

If the rate of admissions due to obesity continues to increase at the same linear rate as it has from 2001/2 to 2011/12, how many admissions would you expect in 2031/32?

A. 22,453
B. 23,437
C. 33,170
D. 134,964
E. 269,928

Question 209:

A shop puts its dresses on sale at 20% off the normal selling price. During the sale, the shop makes a 25% profit over the price at which they bought the dresses. What is the percentage profit when the dresses are sold at full price?

A. 36%
B. 42.5%
C. 56.25%
D. 64%
E. 77%

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Question 210:

The 'Keys MedSoc committee' is made up of 20 students from each of the 6 years at the university. However, the president and vice-president are sabbatical roles (students take a year out from studying). There must be at least two general committee students from each year, as well as the specialist roles. Additionally, the social and welfare officers must be pre-clinical students (years 1-3) but not first years, and the treasurer must be a clinical student (years 4-6).

Which **TWO** of the following statements must be true?

1. There can be a maximum of 13 preclinical (years 1-3) students on the committee.
2. There must be a minimum of 6 2nd and 3rd years.
3. There is an unequal distribution of committee members over the different year groups.
4. There can be a maximum of 10 clinical (years 4-6) students on the committee.
5. There can be a maximum of 2 first year students on the committee.
6. General committee members are equally spread across the 6 years.

A. 1 and 4
B. 2 and 3
C. 2 and 4
D. 3 and 6
E. 4 and 5

Question 211:

Friday the 13th is superstitiously considered an 'unlucky' day. If 13th January 2012 was a Friday, when would the next Friday the 13th be?

A. March 2012
B. April 2012
C. May 2012
D. June 2012
E. July 2012

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Question 212:
A farmer has 18 sheep, 8 of which are male. Unfortunately, 9 sheep die, of which 5 were female. The farmer decides to breed his remaining sheep in order to increase the size of his herd.

Assuming every female gives birth to two lambs, how many sheep does the farmer have after all the females have given birth once?
A. 10
B. 14
C. 15
D. 16
E. 19

Question 213:
Piyanga writes a coded message for Nishita. Each letter of the original message is coded as a letter a specific number of characters further on in the alphabet (the specific number is the same for all letters).

Piyanga's coded message includes the word "PJVN". What could the original word say?
A. CAME
B. DAME
C. FAME
D. GAME
E. LAME

Question 214:
A number of people get on the bus at the station, which is considered the first stop. At each subsequent stop, 1/2 of the people on the bus get off and then 2 people get on. Between the 4th and 5th stop after the station, there are 5 people on the bus.

How many people got on at the station?

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A. 4
B. 6
C. 20
D. 24
E. 30

Question 215:

I have recently moved into a new house, and I am looking to repaint my new living room. The price of several different colours of paint is displayed in the table below. A small can contains enough to paint 10 m^2 of wall. A large can contains enough to paint 25 m^2 of wall.

Colour	Cost for a Small Can	Cost for a Large Can
Red	£4	£12
Blue	£8	£15
Black	£3	£9
White	£2	£13
Green	£7	£15
Orange	£5	£20
Yellow	£10	£12

I decide to paint my room a mixture of blue and white, and I purchase some small cans of blue paint and white paint. The cost of blue paint accounts for 50% of the total cost. I paint a total of 100 m^2 of wall space.

I use up all the paint. How many m^2 of wall space have I painted blue?

A. 10 m^2
B. 20 m^2
C. 40 m^2
D. 50 m^2
E. 80 m^2

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Question 216:

Cakes usually cost 42p at the bakers. The bakers want to introduce a new offer where the amount in pence you pay for each cake is discounted by the square of the number of cakes you buy. For example, buying 3 cakes would mean each cake costs 33p. Isobel says that this is not a good offer from the baker's perspective as it would be cheaper to buy several cakes than just 1.

How many cakes would you have to buy for the total cost to fall below 40p?

A. 2
B. 3
C. 4
D. 5
E. 6

Question 217:

The table below shows the percentages of students in two different universities who take various courses. There are 800 students in University A and 1200 students in University B. Biology, Chemistry and Physics are counted as "Sciences".

	University A	University B
Biology	23.50	13.25
Economics	10.25	14.5
Physics	6.25	14.75
Mathematics	11.50	17.25
Chemistry	30.25	7.00
Psychology	18.25	33.25

Assuming each student only takes one course, how many more students in University A than University B study a "Science"?

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A. 10
B. 25
C. 60
D. 250
E. 600

Question 218:

Traveleasy Coaches charge passengers at a rate of 50p per mile travelled, plus an additional charge of £5.00 for each international border crossed during the journey. Europremier Coaches charge £15 for every journey, plus 10p per mile travelled, with no charge for crossing international borders. Sonia is travelling from France to Germany, crossing 1 international border. She finds that both companies will charge the same price for this journey.

How many miles is Sonia travelling?

A. 10
B. 20
C. 25
D. 35
E. 40

Question 219:

Lauren, Amy and Chloe live in different cities across England. They decide to meet up in London and have a meal together. Lauren departs from Southampton at 2:30 pm and arrives in London at 4:00 pm. Amy's journey lasts twice as long as Lauren's journey and she arrives in London at 4:15 pm. Chloe departs from Sheffield at 1:30 pm, and her journey lasts an hour longer than Lauren's journey.

Which of the following statements is definitely true?

A. Chloe's journey took the longest time.
B. Amy departed after Lauren.
C. Chloe arrived last.
D. Everybody travelled by train.
E. Amy departed before Chloe.

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Question 220:

Emma is packing to go on holiday by aeroplane. On the aeroplane, she can take a case of dimension 50cm by 50cm by 20cm, which, when fully packed, can weigh up to 20kg. The empty suitcase weighs 2kg. In her suitcase, she needs to take 3 books, each of which is 0.2m by 0.1m by 0.05m in size, and weighs 1000g. She would also like to take as many items of clothing as possible. Each item of clothing has volume 1500cm^3 and weighs 400 g.

Assuming each item of clothing can be squashed so as to fill any shape gap, how many items of clothing can she take in her case?

A. 28
B. 31
C. 34
D. 37
E. 40

Question 221:

Alex is buying a new bed and mattress. There are 5 bed shops Alex can buy the bed and mattress he wants from, each of which sells the bed and mattress for a different price. The prices are as follows:

- **Bed Shop A:** Bed £120, Mattress £70
- **Bed Shop B:** All beds and mattresses £90 each
- **Bed Shop C:** Bed £140, Mattress £60. Mattress half price when you buy a bed and mattress together.
- **Bed Shop D:** Bed £140, Mattress £100. Get 33% off when you buy a bed and mattress together.
- **Bed Shop E:** Bed £175. All beds come with a free mattress.

Which is the cheapest place for Alex to buy the bed and mattress from?

A. Bed Shop A
B. Bed Shop B
C. Bed Shop C
D. Bed Shop D
E. Bed Shop E

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Question 222:

In Joseph's sock drawer, there are 21 socks. 4 are blue, 5 are red, 6 are green and the rest are black.

How many socks does he need to take from the drawer in order to guarantee he has a matching pair?

A. 3
B. 4
C. 5
D. 6
E. 7

Question 223:

Printing a magazine uses 1 sheet of card and 25 sheets of paper. It also uses ink. Paper comes in packs of 500 and card comes in packs of 60 which are twice the price of a pack of paper. Each ink cartridge prints 130 sheets of either paper or card. A pack of paper costs £3. Ink cartridges cost £5 each.

How many complete magazines can be printed with a budget of £300?

A. 210
B. 220
C. 230
D. 240
E. 250

Question 224:

Rebecca went swimming yesterday. After a while she had covered one fifth of her intended distance. After swimming six more lengths of the pool, she had covered one quarter of her intended distance.

How many lengths of the pool did she intend to complete?

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A. 40
B. 72
A. 80
B. 100
C. 120

Question 225:
As a special treat, Sammy is allowed to eat five sweets from his very large jar which contains many sweets of each of three flavours – Lemon, Orange and Strawberry. He wants to eat his five sweets in such a way that no two consecutive sweets have the same flavour.

In how many ways can he do this?
A. 32
B. 48
C. 72
D. 108
E. 162

Question 226:
Granny and her granddaughter Gill both had their birthday yesterday. Today, Granny's age in years is an even number and 15 times that of Gill. In 4 years' time Granny's age in years will be the square of Gill's age in years.

How many years older than Gill is Granny today?
A. 42
B. 49
A. 56
B. 60
C. 64

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Question 227:

Pierre said, "Just one of us is telling the truth". Qadr said, "What Pierre says is not true". Ratna said, "What Qadr says is not true". Sven said, "What Ratna says is not true". Tanya said, "What Sven says is not true".

How many of them were telling the truth?

A. 0
B. 1
A. 2
B. 3
C. 4

Question 228:

Two entrants in a school's sponsored run adopt different tactics. Angus walks for half the time and runs for the other half, whilst Bruce walks for half the distance and runs for the other half. Both competitors walk at 3 mph and run at 6 mph. Angus takes 40 minutes to complete the course.

How many minutes does Bruce take?

A. 30
B. 35
A. 40
B. 45
C. 50

Question 229:

Dr Song discovers two new alien life forms on Mars. Species 8472 have one head and two legs. Species 24601 have four legs and one head. Dr Song counts a total of 73 heads and 290 legs in the area.

How many members of Species 8472 are present?

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A. 0
B. 1
C. 72
D. 73
E. 145

Question 230:

A restaurant menu states that: *"All chicken dishes are creamy, and all vegetable dishes are spicy. No creamy dishes contain vegetables."*

Which of the following **must** be true?

A. Some chicken dishes are spicy.
B. All spicy dishes contain vegetables.
C. Some creamy dishes are spicy.
D. Some vegetable dishes contain tomatoes**.**
E. None of the above

Question 231:

Simon and his sister Lucy both cycle home from school. One day, Simon is kept back in detention, so Lucy sets off for home first. Lucy cycles the 8 miles home at 10 mph. Simon leaves school 20 minutes later than Lucy. How fast must he cycle in order to arrive home at the same time as Lucy?

A. 10 mph
B. 14 mph
C. 17 mph
D. 21 mph
E. 24 mph

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Question 232:

Dr. Whu buys 2000 shares in a company at a rate of 50p per share. He then sells the shares for 58p per share. Subsequently, he buys 1000 shares at 55p per share, then sells them for 61p per share. There is a charge of £20 for each transaction of buying or selling shares. What is Dr. Whu's total profit?

A. £140
B. £160
C. £180
D. £200
E. £220

Question 233:

Jina is playing darts. A dartboard is composed of equal segments, numbered from 1 to 20. She takes three throws, and each of the darts lands in a numbered segment. None land in the centre or in double or triple sections. What is the probability that her total score with the three darts is odd?

A. $^1/_4$
B. $^1/_3$
C. $^1/_2$
D. $^3/_5$
E. $^2/_3$

Question 234:

John Morgan invests £5,000 in a savings bond paying 5% interest per annum.

What is the value of the investment in 5 years' time?

A. £6,250
B. £6,315
C. £6,381
D. £6,442
E. £6,570

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Question 235:

Joe is 12 years younger than Michael. In 5 years' time, the sum of their ages will be 62.

How old was Michael two years ago?

A. 20
B. 24
C. 26
D. 30
E. 32

Question 236:

A book has 500 pages. Vicky tears every page out that is a multiple of 3. She then tears out every remaining page that is a multiple of 6. Finally, she tears out half of the remaining pages. I

f the book measures 15 cm x 30cm and is made from paper of weight 110 gm^2, how much lighter is the book now than at the start?

A. 1,648 g
B. 1,698 g
C. 1,722 g
D. 1,790 g
E. 1,848 g

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Question 237:

A farmer is fertilising his crops. The more fertiliser is used, the more the crops grow. Fertiliser costs 80p per kilo. Fertilising at a rate of 0.2 kgm^{-2} increases the crop yield by £1.30 m^{-2}. For each additional 100g of fertiliser above 200g, the extra yield is 30% lower than the linear projection of the stated rate.

At what rate of fertiliser application is it no longer cost effective to increase the dose

A. 0.5 kgm^{-2}
B. 0.6 kgm^{-2}
C. 0.7 kgm^{-2}
D. 0.8 kgm^{-2}
E. 0.9 kgm^{-2}

Question 238:

Pet-Star, Furry Friends and Creature Cuddles are three pet shops, which each sell food for various types of pets.

		Price per Kg in:		
Type of pet food	**Amount of food required per week**	**Pet-star**	**Furry Friends**	**Creature Cuddles**
Guinea Pig	3 Kg	£2	£1	£1.50
Cat	6 Kg	£4	£6	£5
Rabbit	4 Kg	£3	£1	£2.50
Dog	8 Kg	£5	£8	£6
Chinchilla	2 Kg	£1.50	£0.50	£1

Given the information above, which of the following statements can we state is definitely *not* true?

A. Regardless of which of these shops you use, the most expensive animal to provide food for will be a dog.
B. If I own a mixture of cats and rabbits, it will be cheaper for me to shop at Pet-star.
C. If I own 3 cats and a dog, the cheapest place for me to shop is at Pet-star
D. Furry Friends sells the cheapest food for the type of pet requiring the most food
E. If I only have one pet, Creature Cuddles will not be the cheapest place to shop regardless of which type of pet I have.

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Question 239:

I record my bank balance at the start of each month for six months to help me see how much I am spending. My salary is paid on the 10th of each month. At the start of the year, I earn £1000 a month but from March inclusive I receive a pay rise of 10%.

Date	Bank Balance (£)
January 1st	1,200
February 1st	1,029
March 1st	1,189
April 1st	1,050
May 1st	925
June 1st	1,025

In which month did I spend the most money?

A. January
B. February
C. March
D. April
E. May

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Question 240:

Amy needs to travel from Southtown station to Northtown station, which are 100 miles apart. She can travel by 3 different methods: train, aeroplane or taxi. The tables below show the different times for these 3 methods. The taxi takes 1 minute to cover a distance of 1 mile. Aeroplane passengers must be at the airport 30 minutes before their flight. Southtown airport is 10 minutes travelling time from Southtown station and Northtown airport is 30 minutes travelling time from Northtown station.

Train	**Departs Southtown station**	**1400**	**1500**	**1600**
	Arrives Northtown station	1615	1650	1715
Flights	Departs Southtown airport	1610		
	Arrives Northtown airport	1645		

If Amy wants to arrive by 17:00 and wants to set off as late as possible, what method of travel should she choose and what time will she leave Southtown station?

A. Flight, 15:30
B. Train, 16:00
C. Taxi, 15:20
D. Train, 15:00
E. Flight, 16:10

Question 241:

In the multiplication grid to the right, a, b, c and d are all integers. What does d equal?

	c	**d**
a	168	720
b	119	510

A. 18
B. 24
C. 30
D. 40
E. 45

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Question 242:

A sixth form college has 1,500 students. 48% are girls. 80 of the girls are mixed-race. If an equal proportion of boys and girls are mixed race, how many mixed-race boys are there in the college to the nearest 10?

A. 50
B. 60
C. 70
D. 80
E. 90

Question 243:

Christine is a control engineer at the Browdon Nuclear Power Plant. On Wednesday, she is invited to a party on the Friday, and asks her manager if she can take the Friday off. She acknowledged that this will mean she will have worked less than the required number of hours this week and offers to make this up by working extra hours next week. Her manager suggests that instead, she works 5 hours this Sunday, and 3 extra hours next Thursday to make up the required hours. Christine accepts this proposal. Christine's amended schedule for the week is shown below:

Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	8	7	9	6	0	0	5

How many hours was Christine supposed to have worked this week, if she had completed her usual Friday shift?

A. 34
B. 35
C. 36
D. 38
E. 40

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Question 244:

Leonidas notes that the time on a normal analogue clock is 03:40.

What is the smaller angle between the hands on the clock?

A. 110°
B. 120°
C. 130°
D. 140°
E. 150°

Question 245:

Mabel is at an aquarium, looking at a tank that contains crabs and starfish. She counts 8 pincers and 79 legs. Normally, crabs have two pincers and eight legs, and starfish have no pincers and 5 legs. However, one of the starfish was badly injured, and when trying to regenerate one of its legs, it accidentally regrew 3.

Calculate the difference between the number of crabs and starfish.

A. 2
B. 3
C. 4
D. 5
E. 6

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SECTION 1: DATA ANALYSIS

Data analysis questions show a great variation in type and difficulty. The best way to improve with these questions is to do lots of practice questions in order to familiarise yourself with the style of questions.

Options First

Despite the fact that you may have lots of data to contend with, the rule about looking at the options first still stands in this section. This will allow you to register what type of calculation you are required to do and what data you might need to look at for this. Remember, Options → Question → Data/Passage.

Working with Numbers

Percentages frequently make an appearance in this section and it's vital that you're able to work comfortably with them. For example, you should be comfortable increasing and decreasing by percentages, and working out inverse percentages too. When dealing with complex percentages, break them down into their components. For example, 17.5% = 10% + 5% + 2.5%.

Graphs and Tables

When you're working with graphs and tables, it's important that you take a few seconds to check the following before actually extracting data from it.

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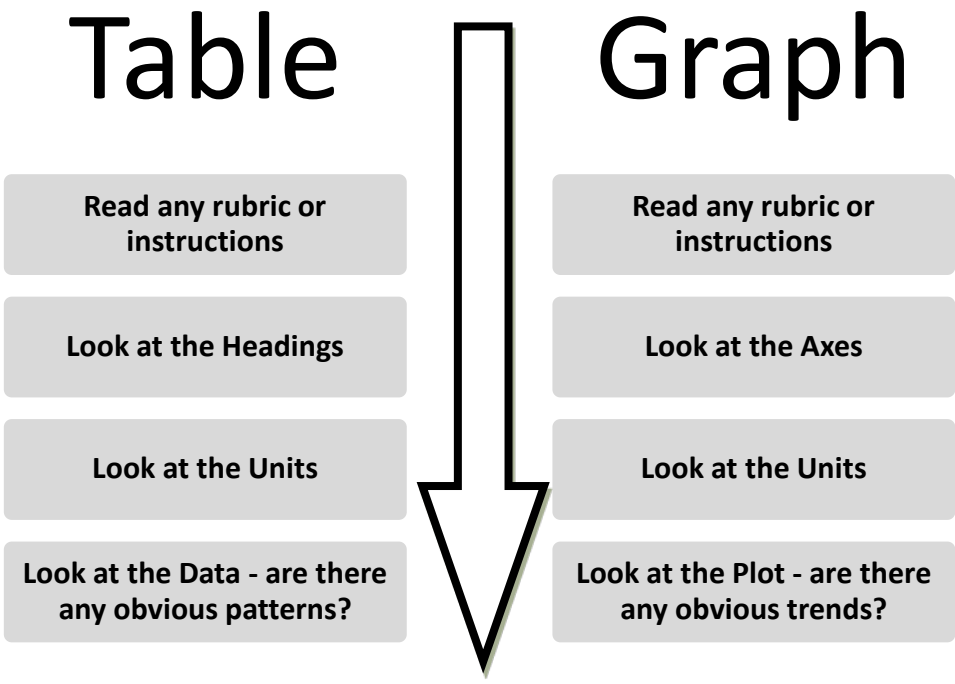
Table
Graph
Read any rubric or instructions
Look at the Headings
Look at the Units
Look at the Data - are there any obvious patterns?
Read any rubric or instructions
Look at the Axes
Look at the Units
Look at the Plot - are there any obvious trends?

Get into the habit of doing this whenever you are faced with data, and you'll find it much easier to approach these questions under time pressure.

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DATA ANALYSIS QUESTIONS

Questions 246 to 248 are based on the following passage:

It has recently been questioned as to whether the recommended five fruit and vegetables a day is sufficient, or if it would be more beneficial to eat 7 fruit and vegetable portions each day. A study at UCL looked at the fruit and vegetables eating habits of 65,000 people in England. Analysis of the data showed that eating more portions was beneficial and vegetables seemed to have a greater protective effect than fruit. The study however did not distinguish whether vegetables themselves have a greater protective effect, or whether these people tend to eat an overall healthier diet. A meta-analysis carried out by researchers across the world complied data from 16 studies which encompassed over 800,000 participants, of whom 56,423 had died.

They found a decline in death of around 5% from all causes for each additional portion of fruit or vegetables eaten, however they recorded no further decline for people who ate over 5 portions. Rates of cardiovascular disease, heart disease or stroke, were shown to decline 4% for each portion up to five, whereas the number of portions of fruit and vegetables eaten seemed to have little impact on cancer rates. The data from these studies points in a similar direction, that eating as much fruit and vegetables a day is preferable, but that five portions is sufficient to have a significant impact on reduction in mortality. Further studies need to look into the slight discrepancies, particularly why the English study found vegetables more protective, and if any specific cancers may be affected by fruit and vegetables even if the general cancer rates more greatly depend on other lifestyle factors.

Question 246:

Which of the following statements is correct?

A. The UCL study found no additional reduction in mortality in those who eat 7 rather than 5 portions of fruit and vegetables a day.
B. People who eat more fruit and vegetables are assumed to have an overall healthier diet which is what gives them the beneficial effect.
C. The meta-analysis found fruit and vegetables are more protective against cancer than cardiovascular disease
D. The English study showed fruit had more protective effects than vegetables.
E. The meta-analysis found no additional reduction in mortality in those who eat 7 rather than 5 portions of fruit and vegetables a day.

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Question 247:

If rates of death were found to be 1% lower in the UCL study than the meta-analysis, approximately how many people died in the UCL study?

A. 3,000
B. 3,200
C. 3,900
D. 4,550
E. 5,200

Question 248

Which statement does the article **MOST** agree with?

A. Eating more fruit and vegetables does not particularly lower the risk of any specific cancers.
B. The UCL research suggests that the guideline should be 7 fruit and vegetables a day for England.
C. The results found by the UCL study and the meta-analysis were contradictory.
D. Many don't eat enough vegetables due to cost and taste.
E. Fruit and vegetables are only protective against cardiovascular disease.

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Questions 249-251 relate to the following table regarding average alcohol consumption in 2010 NB: Some data is missing. **(rotate your device).**

Country	Belarus	Lithuania	Andorra	Grenada	Czech Republic	France	Russia	Ireland
Total		15.4	13.8	12.5	13	12.2		11.9
Recorded Consumption	14.4	12.9		11.9	11.8	11.8	11.5	11.4
Unrecorded consumption	3.2	2.5	1.4	0.7	1.2		3.6	0.5
Beer (%)	17.3		34.6	29.3	53.5	18.8	37.6	48.1
Wine (%)	5.2	7.8		4.3	20.5	56.4	11.4	26.1
Spirits (%)	46.6	34.1	20.1		26	23.1	51	18.7
Other (%)	30.9	11.6	0	0.2	0	1.7	0	7.7
2020 Consumption Projection	17.1	16.2	9.1	10.4	14.1	11.6	14.5	10.9

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Question 249:

Which of the following countries had the highest total beer and wine consumption for 2010?

A. Belarus
B. Lithuania
C. Ireland
D. France
E. Andorra

Question 250:

Which country had the greatest difference for spirit consumption in 2010 and 2020 projection, assuming percentages stay the same?

A. Russia
B. Belarus
C. Lithuania
D. Grenada
E. Ireland

Question 251:

It was later found that some of the percentages of types of alcohol consumed had been mixed up. If the actual amount of beer consumed by each person in the Czech Republic was on average 4.9L, in which country were the percentage figures mixed up with?

A. Lithuania
B. Grenada
C. Russia
D. France
E. Ireland

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Questions 252-255 are based on the following information:

The table below shows the incidence of 6 different types of cancer in Australia:

	Prostate	Lung	Bowel	Bladder	Breast	Uterus
Born Male	40,000	25,000	20,000	8,000	1,000	0
Born Female	0	20,000	18,000	4,000	50,000	9,000

Question 252:

Supposing there are 10 million people who were born male and 10 million people who were born female in Australia, how many percentage points higher is the incidence of cancer amongst women than amongst men?

A. 0.007 %
B. 0.07 %
C. 0.093 %
D. 0.7 %
E. 0.93 %

Question 253:

Now suppose there are 11.5 million people who were born male and 10 million people who were born female in Australia. Assuming all people are equally likely to get each type of cancer, how many of the types of cancer are you more likely to develop if you are born male than if you are born female?

A. 1
B. 2
C. 3
D. 4
E. 5

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Question 254:

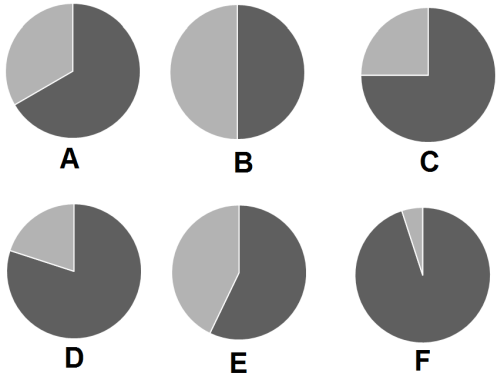
Suppose that prostate, bladder and breast cancer patients visit hospital 1 time during the first month of 2015, and that patients for all other cancers visit hospital 2 times during the first month of 2015. 10% of cancer patients in Australia are in Sydney, and patients in Sydney are not more or less likely to have certain types of cancer than other patients.

How many hospital visits are made by patients in Sydney with these 6 cancers during the first month of 2015?

A. 10,300
B. 18,400
C. 19,500
D. 28,700
E. 195,000

Question 255:

Which of the pie charts represents the combined proportion of people born male vs. female with bladder cancer?



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Questions 256 – 258 are based on the following information:

Units of alcohol are calculated by multiplying the alcohol percentage by the volume of liquid in litres. For example, a 0.75 L bottle of wine, which is 12% alcohol, contains 9 units. 1 pint = 570 ml.

	Volume in bottle/barrel	Standard drinks per bottle/barrel	Percentage
Vodka	1250 ml	50	40%
Beer	10 pints	11.4	3%
Cocktail	750 ml	3	8%
Wine	750 ml	3.75	12.5%

Question 256:

Which standard drink has the most units of alcohol in?

A. Vodka
B. Beer
C. Cocktail
D. Wine
E. Vodka and wine

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Question 257:

Some guidance suggests the recommended maximum number of units of alcohol per week for women is 14. In a week, Hannah drinks 4 standard drinks of wine, 3 standard drinks of beer, 2 standard cocktails and 5 standard vodkas. This guidance states the recommended maximum number of units per week for men is 21. In a week, Mark drinks 2 standard drinks of wine, 6 standard drinks of beer, 3 standard cocktails and 10 standard vodkas.

Who has exceeded their recommended maximum number of units by more and by how many units more have they exceeded it by than the other person?

A. Hannah, by 1 unit
B. Hannah, by 0.5 units
C. Both, by the same
D. Mark, by 0.5 units
E. Mark, by 1 unit

Question 258:

How many different combinations of drinks that total 4 units are there (the same combination in a different order doesn't count).

A. 2
B. 3
C. 4
D. 5
E. 6

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Questions 259-261 relate to the table below which shows information about Greentown's population:

	Female	Male	Total
Under 20	1,930		
20-39	1,960	3,760	5,720
40-59		4,130	
60 and over	2,350	2,250	4,600
Total	11,430	12,890	24,320

Question 259:

How many males under 20 are there in Greentown?

A. 2,650
B. 2,700
C. 2,730
D. 2,750
E. 2,850

Question 260:

How many females aged 40-59 are there in Greentown?

A. Between 3,000 and 4,000
B. Between 4,000 and 5,000
C. Between 5,000 and 6,000
D. Between 6,000 and 7,000
E. Between 6,500 and 8,000

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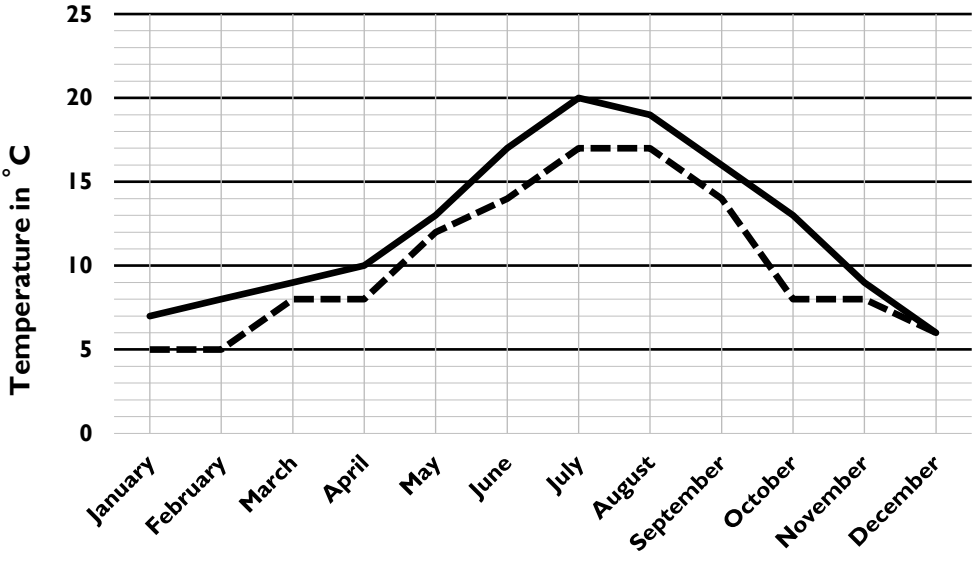
Question 261:

Which is the approximate ratio of females:males in the age group that has the highest ratio of males:females?

A. 1.4:1
B. 1.9:1
C. 1:1.9
D. 1:1.4
E. 1:6:9

Questions 262-264 relate to the follow graph:

The graph below shows the average temperatures in London (solid line) and Newcastle (dashed line).



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Question 262:

If the average monthly temperature for each month is the same every year, how many times during the period May 2007 to September 2013 inclusive is the average temperature the same in 2 consecutive months in Newcastle?

A. 20
B. 24
C. 25
D. 30
E. None of the above.

Question 263:

In how many months in the period specified in the previous question is the average temperature in London AND Newcastle lower than the previous month?

A. 19
B. 21
C. 25
D. 32
E. None of the above

Question 264:

To the nearest 0.5 degrees Celsius, what is the average temperature difference between Newcastle and London?

A. 1.5°C
B. 2°C
C. 2.5 °C
D. 3 °C
E. None of the above.

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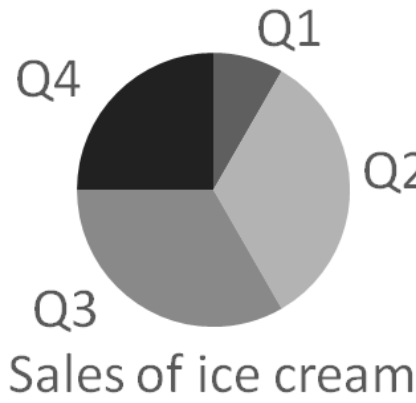
Questions 265-267 concern the following data:

The pie chart to the right shows sales of ice cream across the four quarters of a year from January to December. Sales are lowest in the month of February. From February, they increase in every subsequent month until they get to the maximum sales, and from that point they decrease in every subsequent month until the end of the year. Q2 and Q3 account for 1/3 of the sales each, and Q4 accounts for 1/4 of the sales.



Question 265:

In which month are the sales highest?

A. June
B. July
C. August
D. September
E. Cannot tell

Question 266:

If total sales of ice cream were £354,720 for the year, how much of this was taken during Q1?

A. 29,480
B. £29,560
C. £29,650
D. £29,720
E. £29,800

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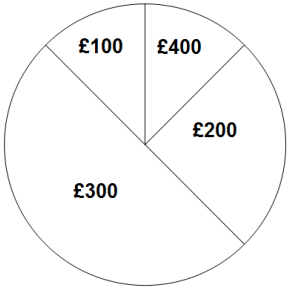
Question 267:

Assuming total sales revenue (i.e. before costs are taken off) is £180,000, and that each tub of ice cream is sold for £2 and costs the manufacturer £1.50 in total production and transportation costs, how much profit is made during Q2?

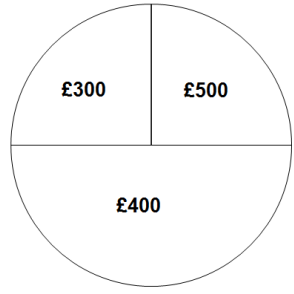
A. £15,000
B. £18,000
C. £30,000
D. £45,000
E. £60,000

Question 268:

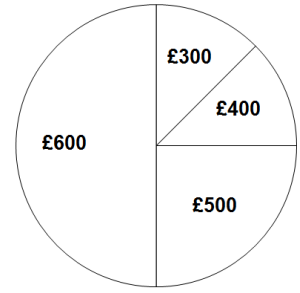
Data on the amount families spend on food per month to the nearest £100 was collected for families with 1, 2 and 3 children. The percentage of families with different spending amounts is displayed below:



1 Child



2 Children



3 Children

Which of the following statements is definitely true?

A. More families with 1 child than families with 2 children spent £300 a month on food.
B. The overall fraction of families spending £600 was 1/6.
C. All of the families with 2 children spent under £4000 on food per year.
D. The fraction of families with 1 child spending £400 on food per month is the same as the fraction of families with 3 children spending this amount.
E. The average amount spent on food by families with 2 children is £410 a month.

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Questions 269-272 are based on the passage below:
A big secondary school recently realised that there were a large number of incidences of bullying occurring that were going unnoticed by teachers. It is possible that some believe bullying to be as much a part of student life as lessons and homework. In order to tackle the problem, the school emailed out a questionnaire to all students' parents and asked them to question their children about whether they had experienced or seen bullying in school. Those children that answered yes were then asked if they had told their teachers about it and asked why they did not if they had not. Those that had told their teacher were asked whether they had seen the teacher act upon the information and whether the bullying had stopped as a result.

Of the 2500 school students surveyed 2210 filled in the online questionnaire. The results showed that, out of 1121 students, almost exactly half (50.7%) had seen bullying in school. Only 396 (35%) of these students told a teacher about the bullying. Of the students who told a teacher, 286 did not witness any action following sharing of the information and of those that did, 60% did not notice any direct action with the bully involved.

From those students who did not report the bullying, 146 gave the reason that they didn't think it was important. 427 cited fears of being found out. 212 students said they did not tell because they didn't think the teachers would do anything about it even if they did know.
Assume that all the students who filled out the survey did so honestly.

Question 269:
To the nearest integer, what percentage of students did not respond?
A. 10%
B. 12%
C. 18%
D. 8%
E. 5%

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Question 270:

If a student saw bullying occur, and did not tell a teacher about it, what is the probability that the reasoning for this is that they thought it to be unimportant?

A. 0.1
B. 0.15
C. 0.2
D. 0.35
E. 0.13

Question 271:

After reporting the bullying, how many students saw the teacher act on the information directly with the bully?

A. 66
B. 44
C. 178
D. 104
E. 118

Question 272:

Which of the following does the questionnaire indicate is the best explanation for why students at the school did not report bullying?

A. Students do not think bullying happens at their school.
B. Students think the teachers will do nothing with the information.
C. Students think that bullying is a part of school life.
D. The students were worried about others finding out.
E. They thought it was unimportant.

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Question 273:

The obesity epidemic is growing rapidly with reports of a three-fold rise in the period from 2007 to 2012. The rates of hospital admission have also been found to vary massively across different areas of England with the highest rates in the North-East (56 per 100,000 people), and the lowest rates in the East of England (12 per 100,000). During almost every year from 2001-12, there were around twice as many women admitted for obesity as men. The reason for this is however unclear and does not imply there are twice as many obese women as men.

Assuming that there were an equal number of men and women living in the area, what was the approximate number of admissions per 100,000 women in the North-East in 2011-12?

A. 18
B. 26
C. 37
D. 56
E. 74

Question 274:

Health professionals are becoming increasingly worried by the decline in exercise being taken by both children and adults. Around only 40% of adults take the recommended amount of exercise, which is 150 minutes per week. As well as falling rates of exercise, a shockingly low number of individuals eat five portions of fruit and vegetables a day. Figures for children aged 5-15 fell to only 16% for boys, and 20% for girls in 2011. Data for adults was only slightly better, with 29% of women and 24% of men eating the recommended number of portions.

Using a figure of 8 million children between 5-15 years (equal ratio of girls to boys) in England in 2011, how many more girls than boys ate 5 portions of fruit and vegetables a day?

A. 80,000
B. 120,000
C. 160,000
D. 320,000
E. 640,000

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Question 275:

The table below shows the leading causes of death in the UK.

	WOMEN		MEN	
Rank	**Cause of Death**	**Number of Deaths**	**Cause of Death**	**Number of Deaths**
1	Dementia and Alzheimer's	31,850	Coronary Heart Disease	37,797
2	Coronary Heart Disease	26,075	Lung Cancer	16,818
3	Stroke	20,706	Dementia and Alzheimer's	15,262
4	Flu and Pneumonia	15,361	Lower Respiratory Disease	15,021
5	Lower Respiratory Disease	14,927	Stroke	14,058
6	Lung Cancer	13,619	Flu and Pneumonia	11,426
7	Breast Cancer	10,144	Prostate Cancer	9,726
8	Colon Cancer	6,569	Colon Cancer	7,669
9	Urinary Infections	5,457	Lymphatic Cancer	6,311
10	Heart Failure	5,012	Liver Disease	4,661
	Total	**261,205**	**Total**	**245,585**

Using information from the table only, which of the following statements is correct?

A. More women died from cancers than men.
B. More than 30,000 women died due to respiratory causes.
C. Dementia and Alzheimer's is more common in women than men.
D. No cause of death is of the same ranking for both men and women.
E. Men are more likely to get cancer than women.

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Question 276:

The government has recently released a campaign leaflet saying that last years' waiting times in NHS A&E departments decreased 20% compared to the year before. The opposition has criticised this statement, saying that there are several definitions which can be described as "waiting times", and the government's campaign leaflet does not make it clear what they mean by "waiting times in A&E".

The NHS watchdog has recently released the following figures describing different aspects of A&E departments, and the change from last year:

Assessment Criterion	2014	2013
Average time spent before being seen in A&E	1 hour	90 minutes
Average time between dialling 999 and receiving treatment in A&E	2 hours	3 hours
Number of people waiting for over 4 hours in A&E	3200	4000
Number of high-priority cases waiting longer than 1 hour	900	1000
Average waiting time for those seen in under 4 hours	50 minutes	40 minutes

Assuming these figures are correct, which criterion of assessment have the government described as "waiting times in A&E" on their campaign leaflet?

A. Number of people waiting for over 4 hours in A&E.
B. Number of people waiting for under 4 hours in A&E.
C. Number of high-priority cases waiting longer than 1 hour.
D. Average time spent before being seen in A&E.
E. Average time between dialling 999 and receiving treatment in A&E.

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Questions 277– 279 refer to the following information:

The table below shows the final standings at the end of the season, after each team has played all the other teams twice each (once at home, once away). The teams are listed in order of how many points they got during the season. Teams get 3 points for a win, 1 point for a draw and 0 points for a loss. No team got the same number of points as another team. Some of the information in the table is missing.

Team	W	D	L
United	8	1	
Athletic	7		
City	7	2	
Town	1	4	
Rovers		0	9
Rangers		2	8

Question 277:

How many points did Rovers get?

A. 0
B. 3
C. 6
D. 9
E. 12

Question 278:

How many games did Athletic lose?

A. 0
B. 1
C. 2
D. 3
E. 4

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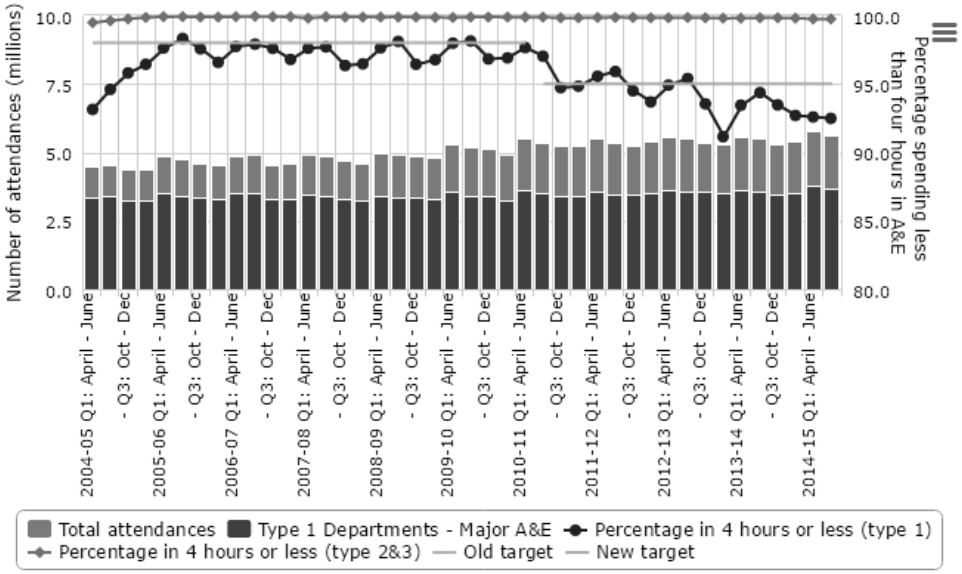
Question 279:

How many more points did United get than Rangers?

A. 7
B. 15
C. 23
D. 25
E. 28

Questions 280-282 use information from the following graph, shows A&E attendances and response times for NHS England from 2004 to 2014.


Number of attendances (millions)
10.0
7.5
5.0
2.5
0.0
100.0
95.0
90.0
85.0
80.0
Percentage spending less than four hours in A&E
2004-05 Q1: April - June
- Q3: Oct - Dec
2005-06 Q1: April - June
- Q3: Oct - Dec
2006-07 Q1: April - June
- Q3: Oct - Dec
2007-08 Q1: April - June
- Q3: Oct - Dec
2008-09 Q1: April - June
- Q3: Oct - Dec
2009-10 Q1: April - June
- Q3: Oct - Dec
2010-11 Q1: April - June
- Q3: Oct - Dec
2011-12 Q1: April - June
- Q3: Oct - Dec
2012-13 Q1: April - June
- Q3: Oct - Dec
2013-14 Q1: April - June
- Q3: Oct - Dec
2014-15 Q1: April - June
Total attendances
Type 1 Departments - Major A&E
Percentage in 4 hours or less (type 1)
Percentage in 4 hours or less (type 2&3)
Old target
New target

Type 1 departments are major A&E units, whereas Type 2 and 3 departments are urgent care centres or minor injury units. The old target (2004 – June 2010) was 97.5%; the new target (July 2010 – 2015) is 95%.

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Question 280:

Which of the following statements is **FALSE**?

A. There has been an overall increase in total A&E attendances from 2004-2014.
B. The number of attendances in Type 1 departments has been fairly constant from 2004-2014.
C. The new target of 4 hours waiting time has only been reached in two quarters by Type 1 departments.
D. The change in attendances is largely due to an increase people going to Type 2 and 3 departments.
E. All the above are true.

Question 281:

By what percentage has the number of total attendances changed from Q1 2004-5 to Q1 2008-9?

A. +5%
B. –5%
C. +10%
D. –10%
E. +15

Question 282:

If the new target was achieved by Type 1 departments 4 times, in what percentage of the quarters was the target missed?

A. 25%
B. 60%
C. 75%
D. 85%
E. 90%

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Questions 283-284 relate to the following data:
Ranjna is travelling from Manchester to Bali. She is required to make a stopover in Singapore, for which she wants to allow at least 2 hours. It takes 14 hours to fly from Manchester to Singapore, and 2 hours from Singapore to Bali. The table below shows the departure times in local time. The timezones for each location are:

- Manchester: GMT
- Singapore: GMT + 8
- Bali: GMT + 8

Manchester to Singapore			Singapore to Bali			
Monday	**Wednesday**	**Thursday**	**Monday**	**Tuesday**	**Wednesday**	**Thursday**
08.00	09.30	02.30	13.00	00.00	15.30	13.00
10.45	14.00	08.30	15.30	07.30	18.00	16.00
13.30	18.00	12.30	21.00	08.30	20.30	19.00
15.00	20.00	19.00		12.00		

Question 283:
What is the latest flight Ranjna can take from Manchester to ensure she arrives at Bali Airport by Thursday 22:00?

A. 18:00 Tuesday
B. 14:00 Wednesday
C. 18:00 Wednesday
D. 20:00 Wednesday
E. 02:30 Thursday

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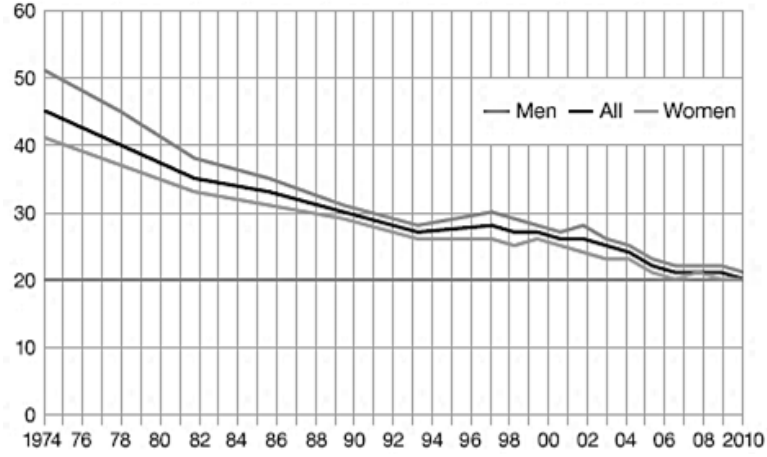
Question 284:

Ranjna takes the 08:00 flight from Manchester to Singapore on Monday. She allows 1 hour to clear customs and collect her luggage at Bali Airport, and another 45 minutes for the taxi to her hotel. At what time will she arrive at the hotel?

A. 16.45 Monday
B. 04:15 Tuesday
C. 10:30 Tuesday
D. 12:15 Tuesday
E. 12:30 Tuesday

Question 285:

The graph below represents the percentage of adult smokers in the UK from 1974 to 2010. The top trace represents men, and the bottom trace represents women. The middle trace is for both men and women.



Which of the following statements can be concluded from the graph?

A. The 2007 smoking ban increased the rate in decline of smokers.
B. There has been a constant reduction in percentage of smokers since 1974.
C. The highest rate in decline in smoking for women was 2004-2006.
D. From 1974 to 2010, the smoking rate in men decreased by half.
E. There has always been a significant difference between the smoking habits of men and women.

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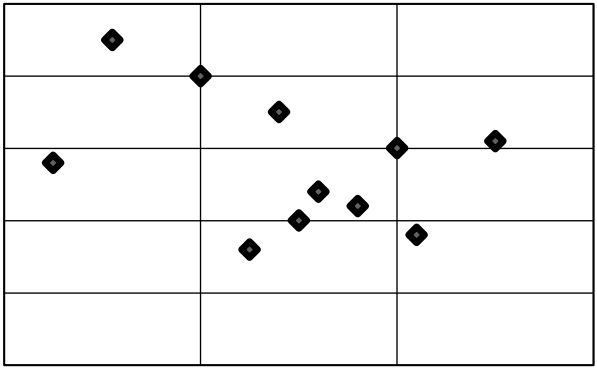
Question 286:

The name, age, height, weight and IQ of 11 people were recorded below in a table and a scatter plot. However, the axis labels were left out by mistake. Scale breaks are permitted.



Name	Age	Height (cm)	Weight (kg)	IQ
Alice	18	180	68	110
Ben	12	160	79	120
Camilla	14	170	62	100
David	25	145	98	108
Eliza	29	165	75	96
Rohan	15	190	92	111
George	20	172	88	104
Hannah	22	168	68	115
Ian	13	182	86	98
James	17	176	90	102
Katie	27	151	66	125

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Which variants are possible for the X and Y axis?

Option	X axis	Y axis
A	Height	Weight
B	IQ	Height
C	Age	IQ
D	Height	IQ
E	Height	Age

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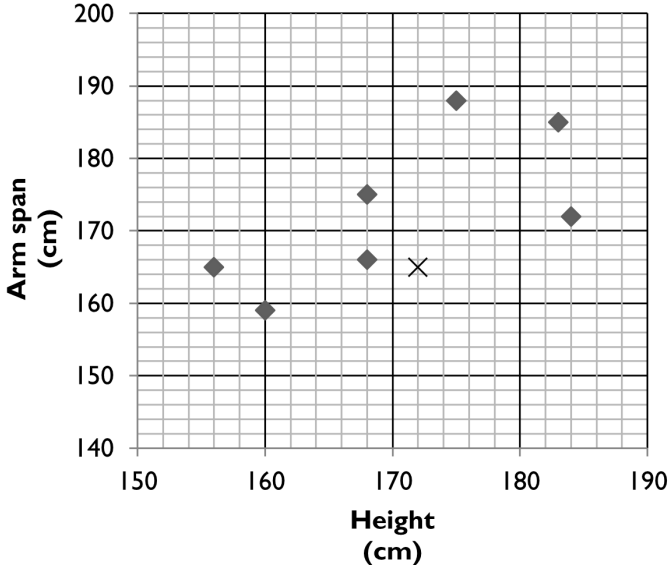
Question 287:

A group of students looked at natural variation in height and arm span within their group and got the following results:

Name	Arm span (cm)	Height (cm)
Adam	175	168
Tom	188	175
Shiv	172	184
Mary	148	142
Alice	165	156
Sarah	166	168
Emily	159	160
Matthew	165	172
Michael	185	183

They then drew a scatter plot but forgot to include names for each point. They also forgot to plot one student.



Which student is represented by the point marked with a cross?

A. Alice
B. Sarah
C. Matthew
D. Adam
E. Emily

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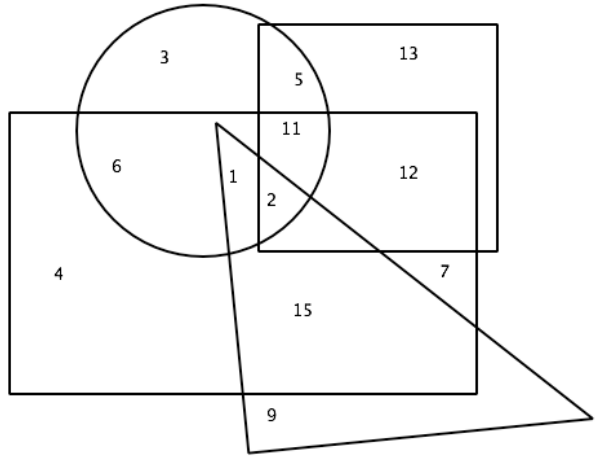
Questions 288 - 294 are based on the following information:

The rectangle represents women. The circle represents those that have children. The triangle represents those that work, and the square those that went to university.



Question 288:

What is the number of non-working women who have children and who did not go to university?

A. 3
B. 5
C. 6
D. 7
E. 9

Question 289:

What is the total number of women who have children and work?

A. 1
B. 2
C. 3
D. 11
E. 14

Question 290:

How many women were surveyed in total?

A. 49
B. 51
C. 58
D. 67
E. 85

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Question 291:

What is the number of people who went to university and had children?

A. 5
B. 11
C. 13
D. 16
E. 18

Question 292:

What is the total number of people who went to university, or have children but not both?

A. 18
B. 28
C. 35
D. 41
E. 53

Question 293:

The total number of men who went to university and had children was?

A. 3
B. 4
C. 5
D. 12
E. 13

Question 294:

Which of the following people were not surveyed?

A. A non-working woman who went to university but did not have children.
B. A working man who went to university and has children.
C. A working woman who had children but did not go to university.
D. A working man who did not have children and did not go to university.
E. A working woman who went to university but did not have children.

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Question 295:

Savers"R"Us is national chain of supermarkets. The price of several items in the supermarket is displayed below:

Item	Price
Beef roasting joint	£8.00
Chicken breast fillet	£6.00
Lamb shoulder	£7.00
Pork belly meat	£4.00
Sausages – 10 pack	£3.50

This week the supermarket has a sale on, with 50% off the normal price of all meat products. Alfred visits the supermarket during this sale and purchases a beef roasting joint, a 10 pack of sausages and a lamb shoulder, paying with a £20 note.

How much change does Alfred get?

A. £1.50
B. £5.00
C. £10.75
D. £11.75
E. £12.50

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Question 296:

The local football league table is shown below, but the number of goals scored against Wilmslow is missing. Each team played the other teams in the league once at home and once away during the season.

Team Name	Points	Goals For	Goals Against
Sale	20	16	2
Wilmslow	16	11	?
Timperley	14	8	7
Altrincham	13	7	9
Mobberley	10	8	12
Hale	8	4	14

How many goals must Wilmslow have conceded?

A. 8
B. 9
C. 10
D. 11
E. 12

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Question 297:

The table below shows the height and the weight that corresponds to different BMI values.

		Weight (lbs)				
		100	105	110	115	120
Height (cm)	152	19	20	22	24	26
	154	18	19	21	23	25
	156	17	18	20	22	24
	158	15	17	19	21	23
	160	14	15	18	20	22
	162	13	14	17	19	21
	164	12	13	15	18	20
	166	11	12	14	17	19
	168	10	11	13	15	18
	170	9	10	12	14	17

Heights and weights of three women with BMIs of 21, 22 and 23 were measured. If Julie and Lydia had different weights but the same height of 154 cm, and the weight of Emma, Lydia and Julie combined was 345 lbs, what was Emma's height?

A. 158 cm
B. 162 cm
C. 160 cm
D. 164 cm
E. 165 cm

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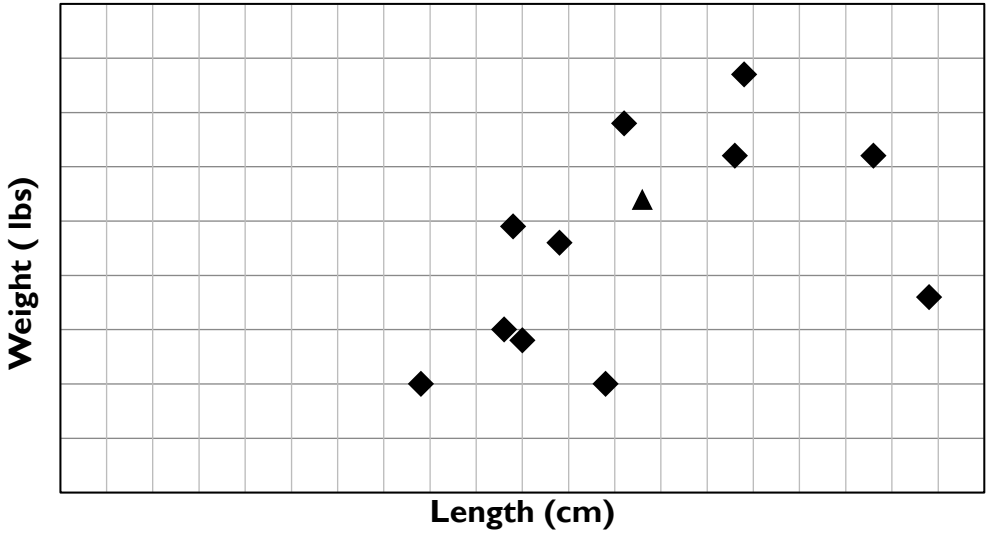
Question 298:

The measurements for different types of fish appear below:

Species	Length (cm)	Weight (lbs)
Bluecup	78	40
Silverfinn	96	60
Starbug	98	98
Jawless	100	56
Lamprene	108	92
Scarfynne	118	40
Rayfish	122	136
Lobefin	126	108
Eringill	146	124
Whaler	148	154
Magic fish	176	124
Blondeye	188	72



Which fish is shown by the point marked by a triangle?

A. Silverfinn
B. Starbug
C. Lobefin
D. Blondeye
E. Eringill

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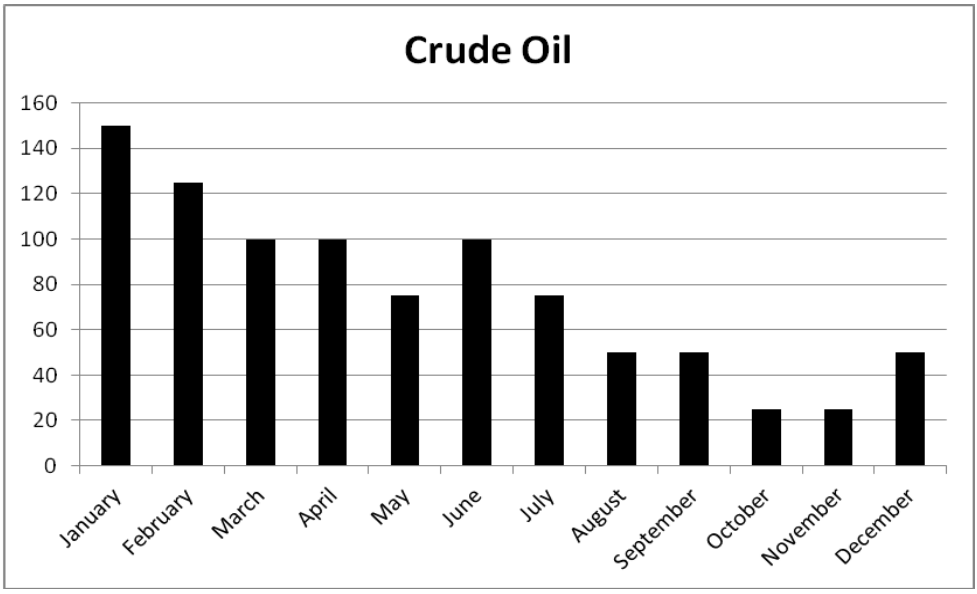
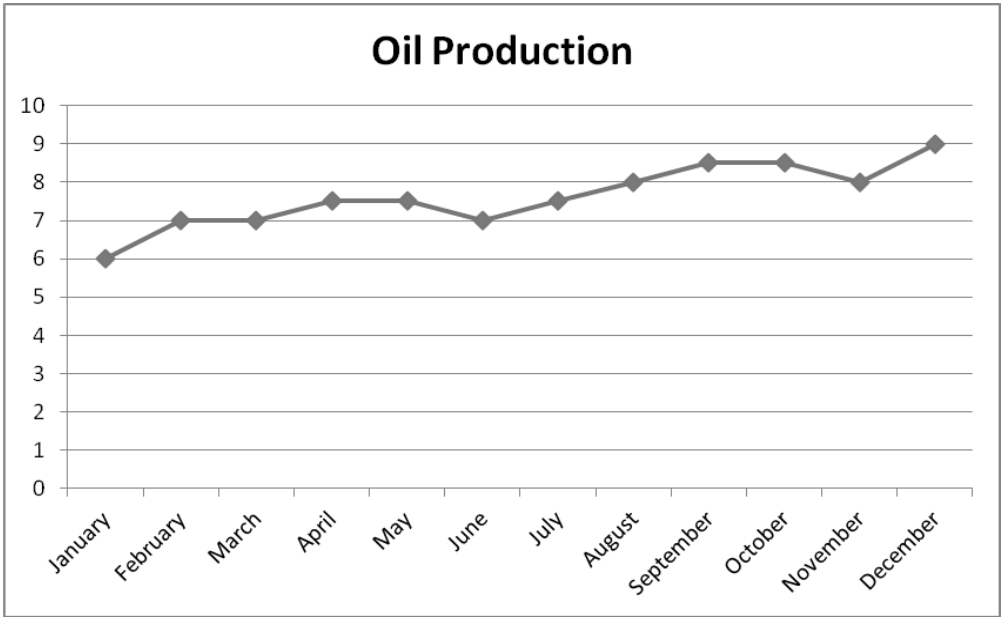
The following graphs are required for questions 299-300:

The graph below shows the price of one barrel of crude oil in US Dollars during 2014:



The graph below shows total oil production, in millions of barrels per day:



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Question 299:

In millions of barrels, what was approximate total oil production in 2014?

A. 1,750
B. 2,146
C. 2,300
D. 2,700
E. 3,500

Question 300:

In billions of dollars, how much did oil sales total in July 2014?

A. $0.56
B. $16.9
C. $17.4
D. $19.4
E. $21.1

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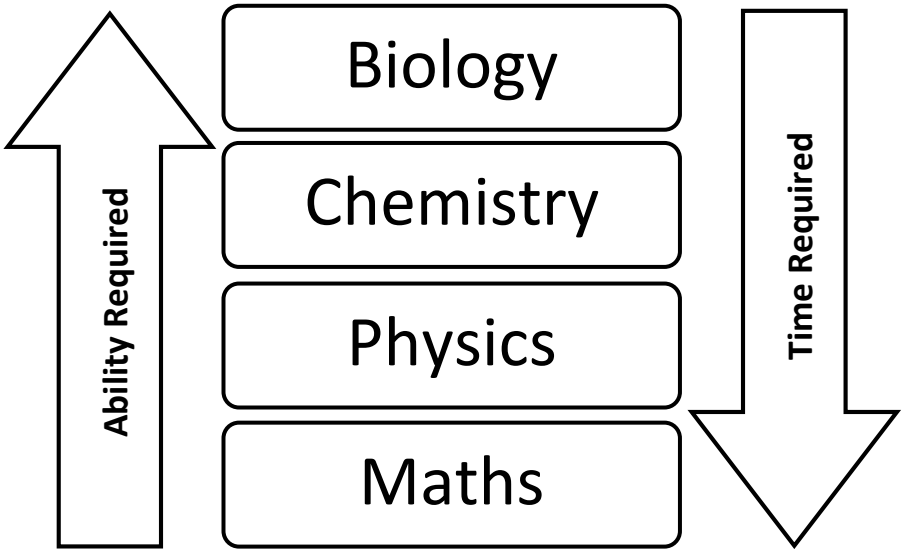
SCIENTIFIC KNOWLEDGE

Sections 2, 3, and 4 are undoubtedly the most time-pressured section of the IMAT. This section tests school biology, chemistry, physics and maths. You have to answer 38 questions in 65 minutes. The questions can be quite difficult and it's easy to get bogged down. However, it's also the section in which you can improve the most quickly in so it's well worth spending time on it.

Although the vast majority of questions in section 2 aren't particularly difficult, the intense time pressure of having to do one question every minute makes this section the hardest in the IMAT. As with section 1, the trick is to identify and do the easy questions whilst leaving the hard ones for the end.

In general, the biology and chemistry questions in the IMAT require the least amount of time per question whilst the maths and physics are more time-draining as they usually consist of multi-step calculations.



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Gaps in Knowledge

The IMAT only tests school level knowledge. However, there is a large variation in content between exam boards meaning that you may not have covered some topics that are examinable. This is more likely if you didn't carry on with Biology or Physics to AS level (e.g. Newtonian mechanics and parallel circuits in physics; hormones and stem cells in biology). If you fall into this category, you are highly advised to go through the IMAT Specification and ensure that you have covered all examinable topics. An electronic copy of this can be obtained from the official IMAT website at www.admissionstestingservice.org/IMAT.

The questions in this book will help highlight any particular areas of weakness or gaps in your knowledge that you may have. Upon discovering these, make sure you take some time to revise these topics before carrying on – there is little to be gained by attempting questions with huge gaps in your knowledge.

Maths

Being confident with maths is extremely important for all sections. Many students find that improving their numerical and algebraic skills usually results in big improvements across all sections scores. Remember that maths not only comes up in the maths questions but also in physics (manipulating equations and standard form) and chemistry (mass calculations). So, if you find yourself consistently running out of time, spending a few hours on brushing up your basic maths skills may do wonders for you.

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SECTION 2: BIOLOGY

Thankfully, the biology questions tend to be fairly straightforward and require the least amount of time. You should be able to do the majority of these within the 100 second limit (often far less). This means that you should be aiming to make up time in these questions. In the majority of cases you'll either know the answer or not – they test advanced recall, so the trick is to ensure that there are no obvious gaps in your knowledge.

Before going onto to do the practice questions in this book, ensure you are comfortable with the following commonly tested topics:

- Structure of animal, plant and bacterial cells
- Osmosis, diffusion and active transport
- Cell division (mitosis + meiosis)
- Family pedigrees and inheritance
- DNA structure and replication
- Gene technology & stem cells
- Enzymes – function, mechanism and examples of digestive enzymes
- Aerobic and anaerobic respiration
- The central vs. peripheral nervous system
- The respiratory cycle including movement of ribs and diaphragm
- The cardiac cycle
- Hormones
- Basic immunology
- Food chains and food webs
- The carbon and nitrogen cycles

Top tip! If you find yourself getting less than 50% of biology questions correct in this book, make sure you revisit the syllabus before attempting more questions as this is the best way to maximise your efficiency. In general, there is no reason why you shouldn't be able to get the vast majority of biology questions correct (and in well under 100 seconds) with sufficient practice.

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BIOLOGY QUESTIONS

Question 301:

In relation to the human genome, which of the following are correct?

1. The DNA genome is coded by 4 different bases.
2. The sugar backbone of the DNA strand is formed of glucose.
3. DNA is found in the nucleus of bacteria.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 302:

Animal cells contain organelles that take part in vital processes. Which of the following is true?

1. The majority of energy production by animal cells occurs in the mitochondria.
2. The cell wall protects the animal cell membrane from outside pressure differences.
3. The endoplasmic reticulum plays a role in protein synthesis.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 303:

With regards to animal mitochondria, which of the following is correct?

A. Mitochondria are not necessary for aerobic respiration.
B. Mitochondria are the sole cause of sperm cell movement.
C. The majority of DNA replication happens inside mitochondria.
D. Mitochondria are more abundant in fat cells than in skeletal muscle.
E. Mitochondria are enveloped by a double membrane.

Question 304:

In relation to bacteria, which of the following is **FALSE**?

A. Bacteria always lead to disease.
B. Bacteria contain plasmid DNA.
C. Bacteria do not contain mitochondria.
D. Bacteria have a cell wall and a plasma membrane.
E. Some bacteria are susceptible to antibiotics.

Question 305:

In relation to bacterial replication, which of the following is correct?

A. Bacteria undergo sexual reproduction.
B. Bacteria have a nucleus.
C. Bacteria carry genetic information on circular plasmids.
D. Bacterial genomes are formed of RNA instead of DNA.
E. Bacteria require gametes to replicate.

Question 306

Which of the following are correct regarding active transport?

A. ATP is necessary and sufficient for active transport.
B. ATP is not necessary but sufficient for active transport.
C. The relative concentrations of the material being transported have little impact on the rate of active transport.
D. Transport proteins are necessary and sufficient for active transport.
E. Active transport relies on transport proteins that are powered by an electrochemical gradient.

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Question 307:
Concerning mammalian reproduction, which of the following is **FALSE**?
A. Fertilisation involves the fusion of two gametes.
B. Reproduction is sexual and the offspring display genetic variation.
C. Reproduction relies upon the exchange of genetic material.
D. Mammalian gametes are diploid cells produced via meiosis.
E. Embryonic growth requires carefully controlled mitosis.

Question 308:
Which of the following apply to Mendelian inheritance?

1. It only applies to plants.
2. It treats different traits as either dominant or recessive.
3. Heterozygotes have a 25% chance of expressing a recessive trait.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 309:
Which of the following statements are correct?
A. Hormones are secreted into the blood stream and act over long distances at specific target organs.
B. Hormones are substances that almost always cause muscles to contract.
C. Hormones have no impact on the nervous or enteric systems.
D. Hormones are always derived from food and never synthesised.
E. Hormones act rapidly to restore homeostasis.

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Question 310:
With regard to neuronal signalling in the body, which of the following are true?

1. Neuronal transmission can be caused by both electrical and chemical stimulation.
2. Synapses ultimately result in the production of an electrical current for signal transduction.
3. All synapses in humans are electrical and unidirectional.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 311:
What is the **primary** reason why pH is controlled so tightly in humans?
A. To allow rapid protein synthesis.
B. To allow for effective digestion throughout the GI tract.
C. To ensure ions can function properly in neural signalling.
D. To prevent changes in electrical charge in polypeptide chains.
E. To prevent changes in core body temperature.

Question 312:
Which of the following statements are correct regarding bacterial cell walls?

1. It confers bacteria protection against external environmental stimuli.
2. It is an evolutionary remnant and now has little functional significance in most bacteria.
3. It is made up primarily of glucose in bacteria.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 313:
Which of the following statements are correct regarding mitosis?

1. It is important in sexual reproduction.
2. A single round of mitosis results in the formation of 2 genetically distinct daughter cells.
3. Mitosis is vital for tissue growth, as it is the basis for cell multiplication.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 314:
Which of the following is the best definition of a mutation?
A. A mutation is a permanent change in DNA.
B. A mutation is a permanent change in DNA that is harmful to an organism.
C. A mutation is a permanent change in the structure of intra-cellular organelles caused by changes in DNA/RNA.
D. A mutation is a permanent change in chromosomal structure caused by DNA/RNA changes.
E. A mutation is a cancer-causing change in DNA or RNA.

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Question 315:

In relation to mutations, which of the following are correct?

1. Mutations always lead to discernible changes in the phenotype of an organism.
2. Mutations are central to natural processes such as evolution.
3. Mutations play a role in cancer.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 316:

Which of the following is the most accurate definition of an antibody?

A. An antibody is a molecule that protects red blood cells from changes in pH.
B. An antibody is a molecule produced only by humans and has a pivotal role in the immune system.
C. An antibody is a toxin produced by a pathogen to damage the host organism.
D. An antibody is a molecule that is used by the immune system to identify and neutralize foreign objects and molecules.
E. Antibodies are small proteins found in red blood cells that help increase oxygen carriage.

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Question 317:
Which of the following statements about the kidney are correct?

1. The kidneys filter the blood and remove waste products from the body.
2. The kidneys are involved in the digestion of food.
3. In a healthy individual, the kidneys produce urine that contains high levels of glucose.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 318:
Which of the following statements are correct?

1. Hormones are slower acting than nerves.
2. Hormones act for a very short time.
3. Hormones act more generally than nerves.
4. Hormones are released when you get a scare.

A. 1 only
B. 1 and 3
C. 2 and 4
D. 1, 3 and 4
E. 1, 2, 3 and 4

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Question 319:
Which statements about homeostasis are correct?

1. Homeostasis is about ensuring the inputs within your body exceed the outputs to maintain a constant internal environment.
2. Homeostasis is about ensuring the inputs within your body are less than the outputs to maintain a constant internal environment.
3. Homeostasis is about balancing the inputs within your body with the outputs to ensure your body fluctuates with the needs of the external environment.
4. Homeostasis is about balancing the inputs within your body with the outputs to maintain a constant internal environment.

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1 and 3

Question 320:
Which of the following statement is true?
A. There is more energy and biomass each time you move up a trophic level.
B. There is less energy and biomass each time you move up a trophic level.
C. There is more energy but less biomass each time you move up a trophic level.
D. There is less energy but more biomass each time you move up a trophic level.
E. There is no difference in the energy or biomass when you move up a trophic level.

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Question 321:
Which of the following statements are true about asexual reproduction?

1. There is no fusion of gametes.
2. There are two parents.
3. There is no mixing of chromosomes.
4. There is genetic variation.

A. 1 and 3
B. 1 and 4
C. 2 and 3
D. 3 and 4
E. 2 and 4

Question 322:
Put the following structures in the order in which they function when Jonas sees a bowl of chicken and moves towards it.

1. Retina
2. Motor neuron
3. Sensory neuron
4. Brain
5. Muscle

A. 1 - 3 - 4 - 5 - 2
B. 1 - 2 - 3 - 4 - 5
C. 5 - 1 - 3 - 2 - 4
D. 1 - 3 - 2 - 4 - 5
E. 1 - 3 - 4 - 2 - 5

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Question 323:
What path does blood take from the kidney to the liver?

1. Pulmonary artery
2. Inferior vena cava
3. Hepatic artery
4. Aorta
5. Pulmonary vein
6. Renal vein

A. 2 - 1 - 4 - 3 - 5 - 6
B. 1 - 2 - 3 - 4 - 5 - 6
C. 6 - 2 - 5 - 1 - 4 - 3
D. 6 - 2 - 1 - 5 - 4 - 3
E. 3 - 2 - 1 - 4 - 6 - 5

Question 324:
Which of the following statements are true about animal cloning?

1. Animals cloned from embryo transplants are genetically identical.
2. The genetic material is removed from an unfertilised egg during adult cell cloning.
3. Cloning can cause a reduced gene pool.
4. Cloning is only possible with mammals.

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1, 2 and 3

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Question 325:
Which of the following statements are true with regard to evolution?

1. Individuals within a species show variation because of differences in their genes.
2. Beneficial mutations will accumulate within a population.
3. Gene differences are caused by sexual reproduction and mutations.
4. Species with similar characteristics never have similar genes.

A. 1 only
B. 1 and 4
C. 2 and 3
D. 2 and 4
E. 1, 2 and 3

Question 326:
Which of the following genetic statements are correct?

1. Alleles are a similar version of different cells.
2. If you are homozygous for a trait, you have three alleles the same for that particular gene.
3. If you are heterozygous for a trait, you have two different alleles for that particular gene.
4. To show the characteristic that is caused by a recessive allele, both carried alleles for the gene have to be recessive.

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 3 and 4

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Question 327:
Which of the following statements are correct about meiosis?

1. The DNA content of a gamete is half that of a human red blood cell.
2. Meiosis requires ATP.
3. Meiosis only takes place in reproductive tissue.
4. In meiosis, a diploid cell divides in such a way so as to produce two haploid cells.

A. 1 only
B. 3 only
C. 1 and 2
D. 2 and 3
E. 2 and 4

Question 328:
Put the following statements in the correct order of events for when there is too little water in the blood.

1. Urine is more concentrated
2. Pituary gland releases ADH
3. Blood water level returns to normal
4. Hypothalamus detects too little water in blood
5. Kidney affects water level

A. 1 - 2 - 3 - 4 - 5
B. 5 - 4 - 3 - 2 - 1
C. 4 - 2 - 5 - 1 - 3
D. 3 - 2 - 4 - 1 - 5
E. 5 - 2 - 3 - 4 - 1

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Question 329:
The pH of venous blood is 7.35. Which of the following is the likely pH of arterial blood?

A. 4.4
B. 5.2
C. 6.5
D. 7.0
E. 7.4

Question 330:
Which of the following are true of the cytoplasm?

1. The vast majority of the cytoplasm is made up of water.
2. All contents of animal cells are contained in the cytoplasm.
3. The cytoplasm contains electrolytes and proteins.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 331:
ATP is produced in which of the following organelles?

1. The Golgi apparatus
2. The rough endoplasmic reticulum
3. The mitochondria
4. The nucleus

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1 and 2

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Question 332:

Which of the following statements about the cell membrane is correct?

A. It made up of a phospholipid bilayer which only allows active transport across it.
B. It is not found in bacteria.
C. It is a semi-permeable barrier to ions and organic molecules.
D. It consists purely of enzymes.
E. It has an overall negative charge.

Question 333:

Cells of the *Polyommatus atlantica* butterfly of the Lycaenidae family have 446 chromosomes. Which of the following statements about a *P. atlantica* butterfly are correct?

1. Mitosis will produce 2 daughter cells each with 223 pairs of chromosomes.
2. Meiosis will produce 4 daughter cells each with 223 chromosomes.
3. Mitosis will produce 4 daughter cells each with 446 chromosomes.
4. Meiosis will produce 2 daughter cells each with 223 pairs of chromosomes.

A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 3 and 4
E. 1, 2 and 3

Questions 334-336 are based on the following information:

Assume that hair colour is determined by a single allele. The R allele is dominant and results in black hair. The r allele is recessive for red hair. Mary (red hair) and Bob (black hair) are having a baby girl.

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Question 334:
What is the probability that she will have red hair?

A. 0%
B. 25%
C. 50%
D. 0% or 25%
E. 0% or 50%

Question 335:
Mary and Bob have a second child, Tim, who is born with red hair. What does this confirm about Bob?

A. Bob is heterozygous for the hair allele.
B. Bob is homozygous dominant for the hair allele.
C. Bob is homozygous recessive for the hair allele.
D. Bob does not have the hair allele.
E. Bob has a new mutation in his hair genes.

Question 336:
Mary and Bob go on to have a third child. What are the chances that this child will be born homozygous for black hair?

A. 0%
B. 25%
C. 50%
D. 75%
E. 100%

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Question 337:
Why does air flow into the chest on inspiration?

1. Atmospheric pressure is lower than intra-thoracic pressure during inspiration.
2. Atmospheric pressure is greater than intra-thoracic pressure during inspiration.
3. Anterior and lateral chest expansion decreases absolute intra-thoracic pressure.
4. Anterior and lateral chest expansion increases absolute intra-thoracic pressure.

A. 1 only
B. 2 only
C. 2 and 3
D. 1 and 4
E. 1 and 3

Question 338:
Which of the following components of a food chain represent the largest biomass?

A. Producers
B. Decomposers
C. Primary consumers
D. Secondary consumers
E. Tertiary consumers

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Question 339:
Concerning the nitrogen cycle, which of the following are true?

1. The majority of the Earth's atmosphere is nitrogen.
2. Most of the nitrogen in the Earth's atmosphere is inert.
3. Bacteria are essential for nitrogen fixation.
4. Nitrogen fixation occurs during lightning strikes.

A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 2 and 4
E. 1,2,3 and 4

Question 340:
Which of the following statements are correct regarding mutations?

1. Mutations always cause proteins to lose their function.
2. Mutations always change the structure of the protein encoded by the affected gene.
3. Mutations always result in cancer.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. None of the above

Question 341:
Which of the following is not a function of the central nervous system?

A. Coordination of movement
B. Decision making and executive functions
C. Sensing painful stimuli
D. Cognition
E. Memory

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Question 342:
Which of the following control mechanisms are involved in modulating cardiac output?

1. Voluntary control.
2. Sympathetic control to decrease heart rate.
3. Parasympathetic control to increase heart rate.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. None of the above

Question 343:
Vijay goes to see his GP with fatty, smelly stools that float on water. Which of the following enzymes is most likely to be malfunctioning?

A. Amylase
B. Lipase
C. Protease
D. Sucrase
E. Lactase

Question 344:
Which of the following statements concerning the cardiovascular system is correct?
A. Oxygenated blood from the lungs flows to the heart via the pulmonary artery.
B. All arteries carry oxygenated blood.
C. The superior vena cava contains oxygenated blood
D. All veins have valves.
E. None of the above.

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Question 345:
Which part of the GI tract has the least amount of enzymatic digestion occurring?

A. Mouth
B. Stomach
C. Small intestine
D. Large intestine
E. Rectum

Question 346:
Oge touches a hot stove and immediately moves her hand away. Which of the following components are **NOT** involved in this reaction?

1. Thermo-receptor
2. Brain
3. Spinal Cord
4. Sensory nerve
5. Motor nerve
6. Muscle

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1, 2 and 3

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Question 347:
Which of the following correctly matches the mode of transport to the scenario?

1. Water moving from a hypotonic solution outside of a potato cell, across the cell wall and cell membrane and into the hypertonic cytoplasm of the potato cell→ Osmosis.
2. Carbon dioxide moving across a respiring cell's membrane and dissolving in blood plasma →Active transport.
3. Reabsorption of amino acids against a concentration gradient in the glomerular apparatus →Diffusion.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 348:
Which of the following equations represents anaerobic respiration?

1. Carbohydrate + Oxygen → Energy + Carbon Dioxide + Water
2. Carbohydrate → Energy + Lactic Acid + Carbon dioxide
3. Carbohydrate → Energy + Lactic Acid
4. Carbohydrate → Energy + Ethanol + Carbon dioxide

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 3 and 4

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Question 349:
Which of the following statements regarding respiration are correct?

1. The mitochondria are the centres for both aerobic and anaerobic respiration.
2. The cytoplasm is the main site of anaerobic respiration.
3. For every two moles of glucose that is respired aerobically, 12 moles of CO_2 are liberated.
4. Anaerobic respiration is more efficient than aerobic respiration.

A. 1 and 2
B. 1 and 4
C. 2 and 3
D. 2 and 4
E. 3 and 4

Question 350:
Which of the following statements are true?

1. The nucleus contains the cell's chromosomes.
2. The cytoplasm consists only of water.
3. The plasma membrane is a single phospholipid layer.
4. The cell wall prevents plants cells from lysing due to osmotic pressure.

A. 1 and 2
B. 1 and 4
C. 1, 3 and 4
D. 1, 2 and 3
E. 1, 2 and 4

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Question 351:
Which of the following statements are true about osmosis?

1. If a medium is hypertonic relative to the cell cytoplasm, the cell will gain water through osmosis.
2. If a medium is hypotonic relative to the cell cytoplasm, the cell will gain water through osmosis.
3. If a medium is hypotonic relative to the cell cytoplasm, the cell will lose water through osmosis.
4. If a medium is hypertonic relative to the cell cytoplasm, the cell will lose water through osmosis.
5. The medium's tonicity has no impact on the movement of water.

A. 1 only
B. 2 only
C. 1 and 3
D. 2 and 4
E. 5 only

Question 352:
Which of the following statements are true about stem cells?

1. Stem cells have the ability to differentiate into other mature types of cells.
2. Stem cells are unable to maintain their undifferentiated state.
3. Stem cells can be classified as embryonic stem cells or adult stem cells.
4. Stem cells are only found in embryos.

A. 1 and 3
B. 3 and 4
C. 2 and 3
D. 1 and 2
E. 2 and 4

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Question 353:
Which of the following are **NOT** examples of natural selection?

1. Giraffes growing longer necks to eat taller plants.
2. Antibiotic resistance developed by certain strains of bacteria.
3. Pesticide resistance among locusts in farms.
4. Breeding of horses to make them run faster.

A. 1 only
B. 4 only
C. 1 and 3
D. 1 and 4
E. 2 and 4

Question 354:
Which of the following statements are true?

1. Enzymes stabilise the transition state and therefore lower the activation energy.
2. Enzymes distort substrates in order to lower activation energy.
3. Enzymes decrease temperature to slow down reactions and lower the activation energy.
4. Enzymes provide alternative pathways for reactions to occur.

A. 1 only
B. 1 and 2
C. 1 and 4
D. 2 and 4
E. 3 and 4

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Question 355:
Which of the following are examples of negative feedback?

1. Salivating whilst waiting for a meal.
2. Throwing a dart.
3. The regulation of blood pH.
4. The regulation of blood pressure.

A. 1 only
B. 1 and 2
C. 3 and 4
D. 2, 3, and 4
E. 1, 2, 3 and 4

Question 356:
Which of the following statements about the immune system are true?

1. White blood cells defend against bacterial and fungal infections.
2. White blood cells can temporarily disable, but not kill, pathogens.
3. White blood cells use antibodies to fight pathogens.
4. Antibodies are produced by bone marrow stem cells.

A. 1 and 3
B. 1 and 4
C. 2 and 3
D. 2 and 4
E. 1, 2, and 3

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Question 357:

The cardiovascular system does **NOT**:

A. Deliver vital nutrients to peripheral cells.
B. Oxygenate blood and transport it to peripheral cells.
C. Act as a mode of transportation for hormones to reach their target organ.
D. Facilitate thermoregulation.
E. Respond to exercise by increasing cardiac output to exercising muscles.

Question 358:

Which of the following statements is correct?

A. Adrenaline can sometimes decrease heart rate.
B. Adrenaline is rarely released during flight or fight responses.
C. Adrenaline causes peripheral vasoconstriction.
D. Adrenaline only affects the cardiovascular system.
E. Adrenaline travels primarily in lymphatic vessels.

Question 359:

Which of the following statements is true?

A. Protein synthesis occurs solely in the nucleus.
B. Each amino acid is coded for by three RNA bases.
C. Each protein is coded for by three amino acids.
D. Red blood cells can create new proteins to prolong their lifespan.
E. Protein synthesis isn't necessary for mitosis to take place.

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Question 360:
A solution of amylase and carbohydrate is present in a beaker, where the pH of the contents is 6.3. Assuming amylase is saturated, which of the following will increase the rate of production of the product?

1. Add sodium bicarbonate
2. Add carbohydrate
3. Add amylase
4. Increase the temperature to 100° C

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1 and 3

Question 361:
Celestial Necrosis is a newly discovered autosomal recessive disorder. A female carrier and a male with the disease produce two boys. What is the probability that neither boy's genotype contains the celestial necrosis allele?

A. 100%
B. 75%
C. 50%
D. 25%
E. 0%

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Question 362:
Which among the following has no endocrine function?

A. The thyroid
B. The ovary
C. The pancreas
D. The testes
E. None of the above.

Question 363:
Which of the following statements are true?

1. Increasing levels of insulin cause a decrease in blood glucose levels.
2. Increasing levels of glycogen cause an increase in blood glucose levels.
3. Increasing levels of adrenaline decrease the heart rate.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 364:
Which of the following rows is correct?

Option	Oxygenated Blood		Deoxygenated Blood	
A.	Left atrium	Left ventricle	Right atrium	Right ventricle
B.	Left atrium	Right atrium	Left ventricle	Right ventricle
C.	Left atrium	Right ventricle	Right atrium	Right ventricle
D.	Right atrium	Right ventricle	Left atrium	Left ventricle
E.	Left ventricle	Right atrium	Left atrium	Right ventricle

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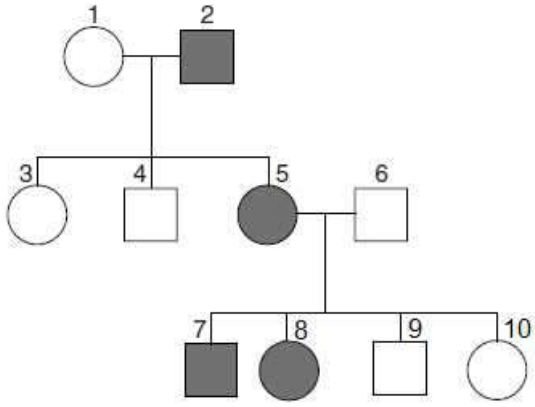
Questions 365-367 are based on the following information:
The pedigree below shows the inheritance of a newly discovered disease that affects connective tissue called Nafram syndrome. Individual 1 is a normal homozygote.



Question 365:
What is the inheritance of Nafram syndrome?

A. Autosomal dominant
B. Autosomal recessive
C. Mitochondrial
D. X-linked recessive
E. Co-dominant

Question 366:
Which individuals must be heterozygous for Nafram syndrome?

A. 1 and 2
B. 8 and 9
C. 2 and 5
D. 5 and 6
E. 6 and 8

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Question 367:
Taking N to denote a diseased allele and n to denote a normal allele, which of the following are **NOT** possible genotypes for 6's parents?

1. NN x NN
2. NN x Nn
3. Nn x nn
4. Nn x Nn
5. nn x nn

A. 1 and 2
B. 1 and 3
C. 2 and 3
D. 2 and 5
E. 3 and 4

Question 368:
Which of the following correctly describes the passage of urine through the body?

Option	1st	2nd	3rd	4th
A.	Kidney	Ureter	Bladder	Urethra
B.	Kidney	Urethra	Bladder	Ureter
C.	Urethra	Bladder	Ureter	Kidney
D.	Ureter	Kidney	Bladder	Urethra
E.	Urethra	Ureter	Kidney	Bladder

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Question 369:
Which of the following best describes the passage of blood from the body, through the heart, back to the body?

A. Aorta → Left Ventricle → Left Atrium → Inferior Vena Cava → Right Atrium → Right Ventricle → Lungs → Aorta
B. Inferior vena cava → Left Atrium → Left Ventricle → Lungs → Right Atrium → Right Ventricle → Aorta
C. Inferior vena cava → Right Ventricle → Right Atrium → Lungs → Left Atrium → Left Ventricle → Aorta
D. Aorta → Left Atrium → Left Ventricle → Lungs → Right Atrium → Right Ventricle → Inferior Vena Cava
E. None of the above.

Question 370:
Which of the following best describes the events during inspiration?

Option	Intrathoracic Pressure	Intercostal Muscles	Diaphragm
A.	Increases	Contract	Contracts
B.	Increases	Relax	Contracts
C.	Increases	Contract	Relaxes
D.	Increases	Relax	Relaxes
E.	Decreases	Contract	Contracts

Questions 371-372 are based on the following information:
DNA is made up of the four nucleotide bases: adenine, cytosine, guanine and thymine. A triplet repeat or codon is a sequence of three nucleotides which code for an amino acid. Whilst there are only 20 amino acids, there are 64 different combinations of the four DNA nucleotide bases. This means that more than one combination of 3 DNA nucleotides sequences code for the same amino acid.

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Question 371:
Which property of the DNA code is described above?
A. The code is unambiguous.
B. The code is universal.
C. The code is non-overlapping.
D. The code is degenerate.
E. The code is preserved.

Question 372:
Which type of mutation does the degenerate property of the genetic code protect against the most?
A. An insertion - where a single nucleotide is inserted.
B. A point mutation - where a single nucleotide is replaced for another.
C. A deletion - where a single nucleotide is deleted.
D. A repeat expansion - where a repeated trinucleotide sequence is added.
E. A duplication - where a piece of DNA is abnormally copied.

Question 373:
Which row of the table below describes what happens when external temperature decreases?

Option	Temperature Change Detected by	Sweat Gland Secretion	Cutaneous Blood Flow
A	Hypothalamus	Increases	Increases
B	Hypothalamus	Increases	Decreases
C	Hypothalamus	Decreases	Increases
D	Hypothalamus	Decreases	Decreases
E	Cerebral Cortex	Increases	Increases

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Question 374:
Which of the following processes involve active transport?

1. Reabsorption of glucose in the kidney.
2. Movement of carbon dioxide into the alveoli in the lungs.
3. Movement of chemicals in a neural synapse.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 375:
Which of the following statements is correct about enzymes?
A. All enzymes are made up of amino acids only.
B. Enzymes can sometimes slow the rate of reactions.
C. Enzymes have no impact on reaction temperatures.
D. Enzymes are heat sensitive but resistant to changes in pH.
E. None of the above.

Question 376:
Which of the following are typically larger in size in eukaryotes than in prokaryotes?

1. Cells
2. Amino acids
3. ATP molecules
4. Ribosomes

A. 1, 2 and 4
B. 1 only
C. 2 and 3
D. 1 and 4
E. 4 only

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Question 377:
Which of the following statements are true about haemoglobin and its functions?

1. Haemoglobin is composed of four iron-containing haem subunits.
2. The Bohr effect describes haemoglobin's increased affinity for oxygen at decreased pH (increased acidity).
3. Haemoglobin can bind hydrogen ions to form haemoglobinic acid.

A. 1 only
B. 1, 2 and 3
C. 1 and 2
D. 1 and 3
E. 2 and 3

Question 378:
Which of the following rows correctly identifies mechanism K as active transport and mechanism J as facilitated diffusion?

Option	Mechanism K	Mechanism J
A	The movement of oxygen from the alveoli to the blood	Can result in the swelling and bursting of cells
B	The uptake of glucose in the intestines	Requires a carrier or channel protein to move large or charged molecules
C	Requires a selectively permeable membrane to move water molecules	Requires ATP to work against a concentration gradient
D	Requires a proton pump to move ions, sugars and amino acids	Movement of small or lipophilic molecules
E	Used to transport bulk material	The movement of minerals into root hair cells of plants

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Question 379:
Which of the following can occur during anaerobic respiration in plants and yeast?

1. Oxidative phosphorylation
2. Production of acetyl-CoA
3. Glycolysis
4. Reversible fermentation

A. 3 only
B. 1, 2 and 3
C. 2 and 3
D. 4 only
E. 2, 3 and 4

Question 380:
Which row of the below table correctly indicates bonds and/or interactions found in **both** primary and secondary protein structures?
✓ = present ✘ = absent

Option	Peptide bonds	Hydrophobic interactions	Disulfide bonds	Hydrogen bonds
A	✓	✘	✘	✘
B	✓	✘	✘	✓
C	✓	✓	✓	✘
D	✓	✓	✓	✘
E	✘	✓	✘	✓

Question 381:
Which of the following groups of enzymes catalyse oxidation reactions?

A. Hydrolases
B. Isomerases
C. Dehydrogenases
D. Polymerases
E. Transcriptases

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Question 382:
Which of the following is NOT a component of the cell membrane?

A. Cholesterol
B. Nucleic acids
C. Phospholipids
D. Glycolipids
E. Glycoproteins

Question 383:
Below are steps involved in a typical microarray experiment to measure changes in gene expression.

- **Step H:** Hybridisation of probes on microarray
- **Step I:** Reverse transcription
- **Step J:** Fluorescence tagging of cDNA
- **Step K:** Isolation of mRNA
- **Step L:** Scanning fluorescence intensity

Which of the following options refers to the correct order for these steps?

A. $K \rightarrow I \rightarrow J \rightarrow H \rightarrow L$
B. $H \rightarrow J \rightarrow L \rightarrow K \rightarrow I$
C. $I \rightarrow L \rightarrow H \rightarrow J \rightarrow K$
D. $K \rightarrow I \rightarrow H \rightarrow J \rightarrow L$
E. $I \rightarrow K \rightarrow J \rightarrow L \rightarrow H$

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Question 384:
Red-green colour blindness in humans is an example of X-linked recessive inheritance, where X^c is the recessive allele that causes colour-blindness and X^+ is the normal dominant allele. If a father has colour-blindness and a mother is a carrier of colour-blindness, what is the probability that their offspring will be colour-blind?

A. 50%
B. 75%
C. 100%
D. 25%
E. 0%

Question 385:
Which of the following statements is NOT true about natural selection and evolution?
A. Antibiotic resistance is an example of natural selection.
B. Evolution results in a change in allele frequencies in the gene pool.
C. Disruptive selection means individuals with extreme phenotypes are less likely to survive.
D. Selection pressures drive directional selection.
E. Natural selection is the result of genetic mutations.

Question 386:
Which of the following statements are correct about genetic diseases?

1. An unaffected carrier of an autosomal dominant condition has a 50% chance of passing the mutated allele to their child.
2. Only men are affected by X-linked recessive conditions.
3. Sickle cell disease is an autosomal recessive disorder.
4. Huntington's disease is an autosomal dominant disorder.

A. 1, 2, 3 and 4
B. 2 and 3
C. 2 only
D. 4 only
E. 3 and 4

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Question 387:
Which of the following statements is/are true about meiosis?

1. Meiosis occurs in the testes in human males.
2. Chiasmata formation and crossing over occurs during prophase I.
3. The second meiotic division creates haploid cells.

A. 2 only
B. 1 only
C. 1, 2 and 3
D. 1 and 2
E. 2 and 3

Question 388:
Which of the following is **true** about the nervous system and synaptic transmission?

A. There are only inhibitory neurotransmitters.
B. Myelination does not affect signal transmission speed.
C. A synapse can exist between a neuron and a non-neuron cell.
D. Signals between neurons can be bidirectional.
E. Na^+ moves out of the neuron during depolarisation.

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Question 389:
Which of following rows correctly refers to word Q, word R, word S and word T of the below sentences about photosynthesis?

"Light energy results in the excitation of electrons in the __Q__ and electrons are passed along a series of electron acceptors in the __R__ membrane. This leads to the production of ATP and __S__, which then drive the light-independent reaction in the __T__."

Option	Word Q	Word R	Word S	Word T
A	Cytoplasm	Stroma	NAPD+	Chlorophyll
B	Mitochondria	Stroma	$NAPDH_2$	Chlorophyll
C	Chlorophyll	Thylakoid	NAPD+	Stroma
D	Stroma	Mitochondrial	$NAPDH_2$	Cytoplasm
E	Chlorophyll	Thylakoid	$NAPDH_2$	Stroma

Question 390:
Which of the following statements is **true** of both prokaryotic and eukaryotic DNA?

A. DNA resides in the cytoplasm.
B. DNA contains intronic sequences.
C. DNA is contained within a membrane.
D. DNA is contained in chromosome form.
E. DNA contains operons.

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Question 391:
Cigarette smoke contains tar, carbon monoxide and nicotine. Which of the following is NOT a damaging effect of tar?

A. Cilia in the bronchi are destroyed.
B. Goblet cells produce more mucus.
C. The diameter of bronchi is reduced.
D. Mutations occur in bronchial epithelial cells.
E. Oxygen-carrying capacity of blood is reduced.

Question 392:
Listed below are various steps related to the sliding filament model of muscular contraction.

1. Calcium ions bind to troponin
2. Myosin head pulls actin filaments towards centre of sarcomere
3. Tropomyosin alters its positioning to expose actin active sites
4. Myosin head binds to actin filaments, forming crossbridges
5. Depolarisation of the sarcolemma

Which of the following options indicates the correct order for these steps?

A. $4 \rightarrow 3 \rightarrow 5 \rightarrow 2 \rightarrow 4$
B. $1 \rightarrow 2 \rightarrow 4 \rightarrow 5 \rightarrow 3$
C. $5 \rightarrow 4 \rightarrow 3 \rightarrow 1 \rightarrow 2$
D. $5 \rightarrow 1 \rightarrow 3 \rightarrow 4 \rightarrow 2$
E. $1 \rightarrow 4 \rightarrow 3 \rightarrow 5 \rightarrow 2$

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Question 393:
Which of the following answers correctly identifies hormone A?

Hormone	Site of secretion	Target organ	Function
A	Pituitary gland	Ovary	Triggers ovulation

A. Follicle-stimulating hormone (FSH)
B. Progesterone
C. Luteinising Hormone (LH)
D. Oestrogen
E. All of the above

Question 394:
An unknown solution has been tested using several biochemical tests. According to the results, what molecule is in the solution being tested?

Test	End result
Benedict's	Blue colour
Iodine (potassium iodide)	Yellow-brown colour
Emulsion (ethanol)	No precipitate
Biuret	Purple colour
Non-reducing sugar + Benedict's	Blue colour

A. Starch
B. Amylase
C. Sucrose
D. Triglycerides
E. Glucose

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Question 395:
Negative feedback systems are used in the body to maintain homeostasis. Which of the following examples represent a negative feedback mechanism?

1. Maintenance of blood glucose levels
2. Osmoregulation by antidiuretic hormone
3. Generation of an action potential
4. Maintenance of body temperature

A. 1 and 4
B. 1, 3 and 4
C. 2 only
D. 1, 2, 3 and 4
E. 1, 2 and 4

Question 396:
Which of the following rows correctly identifies cell type F as T-lymphocytes and cell type G as B-lymphocytes?

	Cell type F	Cell type G
Row 1	Carries out phagocytosis	Binds directly to the foreign antigen
Row 2	Develops into plasma cells	Secretes antibodies
Row 3	Undergoes humoral response	Matures in the thymus gland
Row 4	Secretes cytokines	Matures in bone marrow
Row 5	Matures in the thymus gland	Secretes cytokines

A. Row 4
B. Row 1
C. Row 3
D. Row 5
E. Row 2

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Question 397:

Which is of the following is **not** a function of mitosis?

A. The formation of new blood cells to replace old or damaged cells.
B. The production of genetically non-identical cells.
C. The repair of wounds to the skin.
D. The development of embryos from zygotes.
E. The replenishment of epithelial cells of the small intestine.

Question 398:

Insulin protein is produced in the pancreas and secreted into the blood. Which of the following rows correctly indicates the route of insulin after its production to exiting the cell (from left to right)?

Row 1	Rough ER	Lysosomes	Golgi apparatus	Lysosomes	Plasma membrane
Row 2	Rough ER	Golgi apparatus	Smooth ER	Plasma membrane	Lysosomes
Row 3	Smooth ER	Rough ER	Golgi apparatus	Vesicles	Plasma membrane
Row 4	Rough ER	Vesicles	Smooth ER	Plasma membrane	Vesicles
Row 5	Rough ER	Vesicles	Golgi apparatus	Vesicles	Plasma membrane

A. Row 1
B. Row 3
C. Row 5
D. Row 2
E. Row 4

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Question 399:
After invasion of a host, human immunodeficiency virus (HIV) embeds its genetic material into the host genome. What number of thymine nucleotides would be present in the double-stranded DNA generated after reverse transcription of the RNA sequence listed below?

5' - AUG GCC CCU UCA GGC ACU - 3'

A. 7
B. 3
C. 4
D. 11
E. 6

Question 400:
Which of the following statements is true of the structure of the cardiovascular vessels?

1. Valves are typically found in arteries
2. Elastic fibres are found in both arteries and veins
3. Sphincter muscles are found in the walls of veins

A. 2 only
B. 1, 2 and 3
C. 1 only
D. 2 and 3
E. 1 and 2

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SECTION 3: CHEMISTRY

Most students don't struggle with IMAT chemistry as they'll be studying it at A Level. However, there are certain questions that even good students tend to struggle with under time pressure e.g. balancing equations and mass calculations. It is essential that you're able to do these quickly as they take up by far the most time in the chemistry questions.

Balancing Equations

For some reason, most students are rarely shown how to formally balance equations. Attempting to do so intuitively or via trial and error will only get you so far in the IMAT as the equations you'll have to work with will be fairly complex. To avoid wasting valuable time, it is essential you learn a method that will allow you to solve these in less than 60 seconds on a consistent basis. The method shown below is the simplest way and requires you to be able to do quick mental arithmetic (which is something you should be aiming for anyway). The easiest way to do learn it is through an example:

The following equation shows the reaction between Iodic acid, hydrochloric acid and copper Iodide:

$$\mathbf{a}\ HIO_3 + \mathbf{b}\ CuI_2 + \mathbf{c}\ HCl \rightarrow \mathbf{d}\ CuCl_3 + \mathbf{e}\ ICl + \mathbf{f}\ H_2O$$

What values of **a**, **b**, **c**, **d**, **e** and **f** are needed in order to balance the equation?

	a	b	c	d	e	f
A	5	4	25	4	13	15
B	5	4	20	4	8	15
C	5	6	20	6	8	15
D	2	8	10	8	8	15
E	6	8	24	10	16	15
F	6	10	22	10	16	15

Step 1: Pick an element and see how many atoms there are on the left and right sides.
Step 2: Form an equation to represent this. For Cu: b = d
Step 3: See if any of the answer options don't satisfy b=d. In this case, for option E, b is 8 and d is 10. This allows us to eliminate option E.

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Once you've eliminated as many options as possible, go back to Step 1 and pick another element.
For Hydrogen (H): a + c = 2f

Then see if any of the answer options don't satisfy a + c = 2f.

- Option A: 5 + 25 is equal to 2 x 15
- Option B: 5 + 20 is not equal to 2 x 15
- Option C: 5 + 20 is not equal to 2 x 15
- Option D: 2 + 10 is not equal to 2 x 15

This allows us to eliminate option B, C and D. E has already been eliminated. Thus, the only solution possible is A. This method works best when you get given a table above as this allows you to quickly eliminate options. However, it is still a viable method even if you don't get this information.

Chemistry Calculations

Equations you **MUST** know:

- Atomic Mass = Mass/Moles
- Amount (mol) = Concentration (mol/dm^3) x Volume (dm^3)

Avogadro's Constant:

One mole of anything contains 6 x 10^{23} atoms or molecules of it.
E.g. 5 Moles of water contain 5 x 6 x 10^{23} number of water molecules.

Abundances:

The average atomic mass takes the abundances of all isotopes into account. Thus:
A_r = (Abundance of Isotope 1) x (Mass of Isotope 1) + (Abundance of Isotope 2) x (Mass of Isotope 2) +…
It's easier to understand this by working through examples e.g. **questions 406, 412 and 439**.

> ***Top tip!*** Ensure you're able to convert between **Litres, dm^3, cm^3 and mm^3** quickly and accurately so that you don't make silly mistakes in the real exam when under time pressure.

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CHEMISTRY QUESTIONS

Question 401:

Which of the following most accurately defines an isotope?

A. An isotope is an atom of an element that has the same number of protons in the nucleus but a different number of neutrons orbiting the nucleus.
B. An isotope is an atom of an element that has the same number of neutrons in the nucleus but a different number of protons orbiting the nucleus.
C. An isotope is any atom of an element that can be split to produce nuclear energy.
D. An isotope is an atom of an element that has the same number of protons in the nucleus but a different number of neutrons in the nucleus.
E. An isotope is an atom of an element that has the same number of protons in the nucleus but a different number of electrons orbiting it.

Question 402:

Which of the following is an example of a displacement reaction?

1. $Fe + SnSO4 \rightarrow FeSO_4 + Sn$
2. $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$
3. $H_2SO_4 + Mg \rightarrow MgSO_4 + H_2$
4. $NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$

A. 1 only
B. 1 and 2
C. 2 and 3
D. 3 and 4
E. 1, 2 and 3

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Question 403:
What values of **a**, **b** and **c** are needed to balance the equation below?

$$\mathbf{a}Ca(OH)_2 + \mathbf{b}H_3PO_4 \rightarrow Ca_3(PO_4)_2 + \mathbf{c}H_2O$$

A. a = 3 b = 2 c = 6
B. a = 2 b = 2 c = 4
C. a = 3 b = 2 c = 1
D. a = 1 b = 2 c = 3
E. a = 4 b = 2 c = 6

Question 404:
What values of **s**, **t** and **u** are needed to balance the equation below?

$$\mathbf{s}AgNO_3 + \mathbf{t}K_3PO_4 \rightarrow 3Ag_3PO_4 + \mathbf{u}KNO_3$$

A. s = 9 t = 3 u = 9
B. s = 6 t = 3 u = 9
C. s = 9 t = 3 u = 6
D. s = 9 t = 6 u = 9
E. s = 3 t = 3 u = 9

Question 405:
Which of the following statements are true with regard to displacement?

1. A less reactive halogen can displace a more reactive halogen.
2. Chlorine cannot displace bromine or iodine from an aqueous solution of its salts.
3. Bromine can displace iodine because of the trend of reactivity.
4. Fluorine can displace chlorine as it is higher up the group.
5. Lithium can displace francium as it is higher up the group.

A. 3 only
B. 5 only
C. 1 and 2
D. 3 and 4
E. 2, 3 and 5

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Question 406:
What mass of magnesium oxide is produced when 75g of magnesium is burned in excess oxygen?
Relative Atomic Masses: Mg = 24, O = 16

A. 80 g
B. 100 g
C. 125 g
D. 145 g
E. 175 g

Question 407:
Hydrogen can combine with hydroxide ions to produce water. Which process is involved in this?

A. Hydration
B. Oxidation
C. Reduction
D. Dehydration
E. Evaporation

Question 408:
Which of the following statements about Ammonia are correct?

1. It has a formula of NH_3.
2. Nitrogen contributes 82% to its mass.
3. It can be broken down again into nitrogen and hydrogen.
4. It is covalently bonded.
5. It is used to make fertilisers.

A. 1 and 2
B. 1 and 4
C. 1, 2 and 3
D. 1, 2 and 5
E. 1, 2, 3, 4 and 5

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Question 409:
What colour will a universal indicator change to in a solution of milk and lipase?

A. From green to orange.
B. From red to green.
C. From purple to green.
D. From purple to orange.
E. From yellow to purple.

Question 410:
Vitamin C [$C_6H_8O_6$] can be artificially synthesised from glucose [$C_6H_{12}O_6$]. What type of reaction is this likely to be?

A. Dehydration
B. Hydration
C. Oxidation
D. Reduction
E. Displacement

Question 411:
Which of the following statements are true?

1. Cu^{64} will undergo oxidation faster than Cu^{65}.
2. Cu^{65} will undergo reduction faster than Cu^{64}.
3. Cu^{65} and Cu^{64} have the same number of electrons

A. 1 only
B. 2 only
C. 3 only
D. 2 and 3
E. 1 and 3

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Question 412:

6 g of Mg^{24} is added to a solution containing 30 g of dissolved sulfuric acid (H_2SO_4). Which of the following statements are true? Relative Atomic Masses: S = 32, Mg = 24, O = 16, H = 1

1. In this reaction, the magnesium is the limiting reagent.
2. In this reaction, sulfuric acid is the limiting reagent.
3. The mass of salt produced equals the original mass of sulfuric acid.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 413:

In which of the following mixtures will a displacement reaction occur?

1. $Cu + 2AgNO_3$
2. $Cu + Fe(NO_3)_2$
3. $Ca + 2H_2O$
4. $Fe + Ca(OH)_2$

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 414:
Which of the following statements is true about the following chain of metals?

$$Na \rightarrow Ca \rightarrow Mg \rightarrow Al \rightarrow Zn$$

Moving from left to right:

1. The reactivity of the metals increases.
2. The likelihood of corrosion of the metals increases.
3. More energy is required to separate these metals from their ores.
4. The metals lose electrons more readily to form positive ions.

A. 1 and 2
B. 1and 3
C. 2 and 3
D. 1, 2, 3 and 4
E. None of the above

Question 415:
In which of the following mixtures will a displacement reaction occur?

1. I_2 + 2KBr
2. Cl_2 + 2NaBr
3. Br_2 + 2KI

A. 1 only
B. 2 only
C. 3 only
D. 2 and 3
E. 1, 2 and 3

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Question 416:
Which of the following statements about Al and Cu are true?

1. Al is used to build aircraft because it is lightweight and resists corrosion.
2. Cu is used to build electrical wires because it is a good insulator.
3. Both Al and Cu are good conductors of heat.
4. Al is commonly alloyed with other metals to make coins.
5. Al is resistant to corrosion because of a thin layer of aluminium hydroxide on its surface.

A. 1 and 3
B. 1 and 4
C. 1, 3 and 5
D. 1, 3, 4, 5
E. 2, 4 and 5

Question 417:
21 g of Li^7 reacts completely with excess water. Given that the molar gas volume is 24 dm^3 under the conditions, what is the volume of hydrogen produced?

A. 12 dm^3
B. 24 dm^3
C. 36 dm^3
D. 48 dm^3
E. 72 dm^3

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Question 418:
Which of the following statements regarding bonding are true?

1. NaCl has stronger ionic bonds than $MgCl_2$.
2. Transition metals are able to lose varying numbers of electrons to form multiple stable positive ions.
3. All covalently bonded structures have lower melting points than ionically bonded compounds.
4. All covalently bonded structures do not conduct electricity.

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1 and 2

Question 419:
Consider the following two reactions:

A. $C + O_2 \rightarrow CO_2$ $\Delta H = -394$ kJ per mole
B. $CaCO_3 \rightarrow CaO + CO_2$ $\Delta H = +178$ kJ per mole

Which of the following statements are true?

1. Reaction **A** is exothermic and Reaction **B** is endothermic.
2. CO_2 has less energy than C and O_2.
3. CaO is more stable than $CaCO_3$.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 420:
Which of the following are true of regarding the oxides formed by Na, Mg and Al?

1. All of the metals and their solid oxides conduct electricity.
2. MgO has stronger bonds than Na_2O.
3. Metals are extracted from their molten ores by fractional distillation.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 421:
Which of the following pairs have the same electron configuration?

1. Li^+ and Na^+
2. Mg^{2+} and Ne
3. Na^{2+} and Ne
4. O^{2+} and a carbon atom

A. 1 only
B. 1 and 2
C. 1 and 3
D. 2 and 3
E. 2 and 4

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Question 422:
In relation to reactivity of elements in Group 1 and 2, which of the following statements is correct?

1. Reactivity decreases as you go down Group 1.
2. Reactivity increases as you go down Group 2.
3. Group 1 metals are generally less reactive than Group 2 metals.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

Question 423:
What role do catalysts fulfil in an endothermic reaction?
A. They increase the temperature, causing the reaction to occur at a faster rate.
B. They decrease the temperature, causing the reaction to occur at a faster rate.
C. They reduce the energy of the reactants in order to trigger the reaction.
D. They reduce the activation energy of the reaction.
E. They increase the activation energy of the reaction.

Question 424:
Tritium H^3 is an isotope of Hydrogen. Why is tritium commonly referred to as 'heavy hydrogen'?
A. Because H^3 contains 3 protons making it heavier than H^1 that contains 1 proton.
B. Because H^3 contains 3 neutrons making it heavier than H^1 that contains 1 neutron.
C. Because H^3 contains 1 neutron and 2 protons making it heavier than H^1 that contains 1 neutron and 1 proton.
D. Because H^3 contains 1 proton and 2 neutrons making it heavier than H^1 that contains 1 proton.
E. Because H^3 contains 3 electrons making it heavier than H^1 that contains 1 electron.

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Question 425:
In relation to redox reactions, which of the following statements are correct?

1. Oxidation describes the loss of electrons.
2. Reduction increases the electron density of an ion, atom or molecule.
3. Halogens are powerful reducing agents.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

Question 426:
Which of the following statements is correct?
A. At higher temperatures, gas molecules move at angles that cause them to collide with each other more frequently.
B. Gas molecules have lower energy after colliding with each other.
C. At higher temperatures, gas molecules attract each other resulting in more collisions.
D. The average kinetic energy of gas molecules is the same for all gases at the same temperature.
E. The momentum of gas molecules decreases as pressure increases.

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Question 427:
Which of the following are exothermic reactions?

1. Burning magnesium in pure oxygen
2. The combustion of hydrogen
3. Aerobic respiration
4. Evaporation of water in the oceans
5. Reaction between a strong acid and a strong base

A. 1, 2 and 4
B. 1, 2 and 5
C. 1, 3 and 5
D. 2, 3 and 4
E. 1, 2, 3 and 5

Question 428:
Ethene reacts with oxygen to produce water and carbon dioxide. Which elements are oxidised/reduced?

A. Carbon is reduced and oxygen is oxidised.
B. Hydrogen is reduced and oxygen is oxidised.
C. Carbon is oxidised and hydrogen is reduced.
D. Hydrogen is oxidised and carbon is reduced.
E. Carbon is oxidised and oxygen is reduced.

Question 429:
In the reaction between zinc and copper (II) sulphate which elements act as oxidising + reducing agents?
A. Zinc is the reducing agent while sulfur is the oxidizing agent.
B. Zinc is the reducing agent while copper in $CuSO_4$ is the oxidizing agent.
C. Copper is the reducing agent while zinc is the oxidizing agent.
D. Oxygen is the reducing agent while copper in $CuSO_4$ is the oxidizing agent.
E. Sulfur is the reducing agent while oxygen is the oxidizing agent.

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Question 430:
Which of the following statements is true?
A. Acids are compounds that act as proton acceptors in aqueous solution.
B. Strong acids will turn universal indicator solution red or orange.
C. Strong acids are partially ionized in a solution.
D. Weak acids generally have a pH of 7-8.
E. The reaction between a weak and strong acid produces water and salt.

Question 431:
An unknown element, Z, has 3 isotopes: Z^5, Z^6 and Z^8. Given that the atomic mass of Z is 7, and the relative abundance of Z^5 is 20%, which of the following statements are correct?

1. Z^5 and Z^6 are present in the same abundance.
2. Z^8 is the most abundant of the isotopes.
3. Z^8 is more abundant than Z^5 and Z^6combined.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

Question 432:
Which of following best describes the products when an acid reacts with a metal that is more reactive than hydrogen?

A. Salt and hydrogen
B. Salt and ammonia
C. Salt and water
D. A weak acid and a weak base
E. A strong acid and a strong base

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Question 433:

Choose the option which balances the following equation:

a $FeSO_4$ + **b** $K_2Cr_2O_7$ + **c** H_2SO_4 → **d** $(Fe)_2(SO_4)_3$ + **e** $Cr_2(SO_4)_3$ + **f** K_2SO_4 + **g** H_2O

Option	a	b	c	d	e	f	g
A	6	1	8	3	1	1	7
B	6	1	7	3	1	1	7
C	2	1	6	2	1	1	6
D	12	1	14	4	1	1	14
E	4	1	12	4	1	1	12

Question 434:

Which of the following statements is correct?

A. Matter consists of atoms that have a net electrical charge.
B. Atoms and ions of the same element have different numbers of protons and electrons but the same number of neutrons.
C. Over 80% of an atom's mass is provided by protons.
D. Atoms of the same element that have different numbers of neutrons react at significantly different rates.
E. Protons in the nucleus of atoms repel each other as they are positively charged.

Question 435:

Which of the following statements is correct?

A. The noble gases are chemically inert and therefore useless to man.
B. All the noble gases have a full outer electron shell.
C. The majority of noble gases are brightly coloured.
D. The boiling point of the noble gases decreases as you progress down the group.
E. Neon is the most abundant noble gas.

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Question 436:
In relation to alkenes, which of the following statements is correct?

1. They all contain double bonds.
2. They can all be reduced to alkanes.
3. Aromatic compounds are also alkenes as they contain double bonds.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

Question 437:
Chlorine is made up of two isotopes, Cl^{35} (atomic mass 34.969) and Cl^{37} (atomic mass 36.966). Given that the atomic mass of chlorine is 35.453, which of the following statements is correct?
Cl^{35} is about 3 times more abundant than Cl^{37}.
A. Cl^{35} is about 10 times more abundant than Cl^{37}.
B. Cl^{37} is about 3 times more abundant than Cl^{35}.
C. Cl^{37} is about 10 times more abundant than Cl^{35}.
D. Both isotopes are equally abundant.

Question 438:
Which of the following statements regarding transition metals is correct?
A. Transition metals form ions that have multiple colours.
B. Transition metals usually form covalent bonds.
C. Transition metals cannot be used as catalysts as they are too reactive.
D. Transition metals are poor conductors of electricity.
E. Transition metals occupy Groups 1 and 2 of the Periodic Table.

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Question 439:
20 g of impure Na^{23} reacts completely with excess water to produce 8,000 cm^3 of hydrogen gas under standard conditions. What is the percentage purity of sodium? (Under standard conditions 1 mole of gas occupies 24 dm^3)

A. 88.0%
B. 76.5%
C. 66.0%
D. 38.0%
E. 15.3%

Question 440:
An organic molecule contains 70.6% Carbon, 5.9% Hydrogen and 23.5% Oxygen. It has a molecular mass of 136. What is its chemical formula?

A. C_4H_4O
B. C_5H_4O
C. $C_8H_8O_2$
D. $C_{10}H_8O_2$
E. C_2H_2O

Question 441:
Choose the option which balances the following reaction:

$$\mathbf{a}S + \mathbf{b}HNO_3 \rightarrow \mathbf{c}H_2SO_4 + \mathbf{d}NO_2 + \mathbf{e}H_2O$$

Option	a	b	c	d	e
A	3	5	3	5	1
B	1	6	1	6	2
C	6	14	6	14	2
D	2	4	2	4	4
E	2	3	2	3	2

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Question 442:
Which of the following statements is true?

1. Ethane and ethene can both dissolve in organic solvents.
2. Ethane and ethene can both be hydrogenated in the presence of Nickel.
3. Breaking C=C requires double the energy needed to break C-C.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 443:
Diamond, graphite, methane and ammonia all exhibit covalent bonding. Which row correctly describes the properties associated with each?

	Compound	Melting Point	Able to conduct electricity	Soluble in water
1.	Diamond	High	Yes	No
2.	Graphite	High	Yes	No
3.	$CH_{4\,(g)}$	Low	No	No
4.	$NH_{3\,(g)}$	Low	No	Yes

A. 1 and 2
B. 2 and 3
C. 1 and 3
D. 2, 3 and 4
E. 1,2 and 4

Question 444:
Which of the following statements about catalysts are true?

1. Catalysts reduce the energy required for a reaction to take place.
2. Catalysts are used up in reactions.
3. Catalysed reactions are almost always exothermic.

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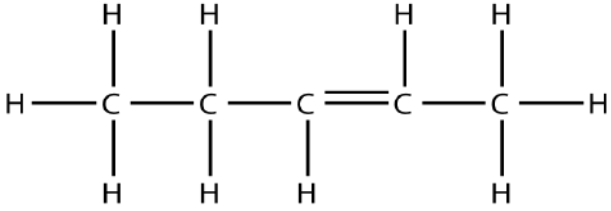
A. 1 only
B. 2 only
C. 1 and 2
D. 2 and 3
E. 3 only

Question 445:
What is the name of the molecule below?



A. But-1-ene
B. But-2-ene
C. Pent-3-ene
D. Pent-1-ene
E. Pent-2-ene

Question 446:
Which of the following statements is correct regarding Group 1 elements (excluding hydrogen)?
A. The oxidation number of Group 1 elements usually decreases in most reactions.
B. Reactivity decreases as you progress down Group 1.
C. Group 1 elements do not react with water.
D. All Group 1 elements react spontaneously with oxygen.
E. All of the above.

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Question 447:
Which of the following statements about electrolysis are correct?

1. The cathode attracts negatively charged ions.
2. Atoms are reduced at the anode.
3. Electrolysis can be used to separate mixtures.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. None of the above.

Question 448:
Which of the following is **NOT** an isomer of pentane?
A. None of the below.
B. $CH_3CH_2CH_2CH_2CH_3$
C. $CH_3C(CH_3)CH_3CH_3$
D. $CH_3(CH_2)_3CH_3$
E. $CH_3C(CH_3)_2CH_3$

Question 449:
Choose the option which balances the following reaction:

$$Cu + HNO_3 \rightarrow Cu(NO_3)_2 + NO + H_2O$$

A. $8\ Cu + 3\ HNO_3 \rightarrow 8\ Cu(NO_3)_2 + 4\ NO + 2\ H_2O$
B. $3\ Cu + 8\ HNO_3 \rightarrow 2\ Cu(NO_3)_2 + 3\ NO + 4\ H_2O$
C. $5Cu + 7HNO_3 \rightarrow 5\ Cu(NO_3)_2 + 4\ NO + 8\ H_2O$
D. $6\ Cu + 10\ HNO_3 \rightarrow 6\ Cu(NO_3)_2 + 3\ NO + 7\ H_2O$
E. $3\ Cu + 8\ HNO_3 \rightarrow 3\ Cu(NO_3)_2 + 2\ NO + 4\ H_2O$

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Question 450:

What of the following statements regarding alkenes is correct?

A. Alkenes are an inorganic homologous series.
B. Alkenes always have three times as many hydrogen atoms as they do carbon atoms.
C. Bromine water changes from clear to brown in the presence of an alkene.
D. Alkenes are more reactive than alkanes because they are unsaturated.
E. Alkenes frequently take part in subtraction reactions.

Question 451:

Which of the following statements is correct regarding Group 17?

A. All Group 17 elements are electrophilic and therefore form negatively charged ions.
B. All Group 17 elements are gases at room temperature.
C. The reaction between sodium and fluorine is less vigorous than sodium and iodine.
D. All Group 17 elements are non-coloured.
E. Some Group 17 elements are found naturally as unbonded atoms.

Question 452:

Why does the electrolysis of NaCl solution (brine) require the strict separation of the products of anode and cathode?

A. To prevent the preferential discharge of ions.
B. In order to prevent spontaneous combustion.
C. In order to prevent production of H_2.
D. In order to prevent the formation of HCl.
E. In order to avoid CO poisoning.

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Question 453:
In relation to the electrolysis of brine (NaCl), which of the following statements are correct?

1. Electrolysis results in the production of hydrogen and chlorine gas.
2. Electrolysis results in the production of sodium hydroxide.
3. Hydrogen gas is released at the anode and chlorine gas is released at the cathode.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 1 and 3

Question 454:
Which of the following statements is correct?
A. Alkanes consist of multiple C-H bonds that are very weak.
B. An alkane with 14 hydrogen atoms is called heptane.
C. All alkanes consist purely of hydrogen and carbon atoms.
D. Alkanes burn in excess oxygen to produce carbon monoxide and water.
E. Bromine water is decolourised in the presence of an alkane.

Question 455:
Which of the following statements are correct?

1. All alcohols contain a hydroxyl functional group.
2. Alcohols are highly soluble in water.
3. Alcohols are sometimes used as biofuels.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 3
E. 1, 2 and 3

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Question 456:
Which row of the table below is correct?

	Non-Reducible Hydrocarbon			Reducible Hydrocarbon		
A	C_nH_{2n}	$Br_{2(aq)}$ remains brown	Saturated	C_nH_{2n+2}	Turns $Br_{2(aq)}$ colourless	Unsaturated
B	C_nH_{2n+2}	Turns $Br_{2(aq)}$ colourless	Unsaturated	C_nH_{2n}	$Br_{2(aq)}$ remains brown	Saturated
C	C_nH_{2n}	$Br_{2(aq)}$ remains brown	Unsaturated	C_nH_{2n+2}	Turns $Br_{2(aq)}$ colourless	Saturated
D	C_nH_{2n+2}	Turns $Br_{2(aq)}$ colourless	Saturated	C_nH_{2n}	$Br_{2(aq)}$ remains brown	Unsaturated
E	C_nH_{2n+2}	$Br_{2(aq)}$ remains brown	Saturated	C_nH_{2n}	Turns $Br_{2(aq)}$ colourless	Unsaturated

Question 457:
How many grams of magnesium chloride are formed when 10 grams of magnesium oxide are dissolved in excess hydrochloric acid? Relative atomic masses: Mg = 24, O = 16, H = 1, Cl = 35.5

A. 10.00
B. 14.95
C. 20.00
D. 23.75
E. 47.55

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Question 458:
Pentadecane has the molecular formula $C_{15}H_{32}$. Which of the following statements is true?

A. Pentadecane has a lower boiling point than pentane.
B. Pentadecane is more flammable than pentane.
C. Pentadecane is more volatile than pentane.
D. Pentadecane is more viscous than pentane.
E. All of the above.

Question 459:
The rate of reaction is normally dependent upon:

1. The temperature.
2. The concentration of reactants.
3. The concentration of the catalyst.
4. The surface area of the catalyst.

A. 1 and 2
B. 2 and 3
C. 2, 3 and 4
D. 1, 3 and 4
E. 1, 2, 3 and 4

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Question 460:
The equation below shows the complete combustion of a sample of unknown hydrocarbon in excess oxygen.

$$C_aH_b + O_2 \rightarrow \boldsymbol{c}CO_2 + \boldsymbol{d}H_2O$$

The product yielded 176 grams of CO_2 and 108 grams of H_2O. What is the most likely formula of the unknown hydrocarbon? Relative atomic masses: H = 1, C = 12, O = 16.

A. CH_4
B. CH_3
C. C_2H_6
D. C_3H_9
E. C_2H_4

Question 461:
What type of reaction must ethanol undergo in order to be converted to ethylene oxide (C_2H_4O)?

A. Oxidation
B. Reduction
C. Dehydration
D. Hydration
E. Redox

Question 462:
What values of *a, b* and *c* balance the equation below?

$$\boldsymbol{a}\ Ba_3N_2 + 6H_2O \rightarrow \boldsymbol{b}\ Ba(OH)_2 + \boldsymbol{c}\ NH_3$$

Option	a	b	c
A	1	2	3
B	1	3	2
C	2	1	3
D	2	3	1
E	3	1	2

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Question 463:
What values of *a, b* and *c* balance the equation below?

$$\boldsymbol{a}\ FeS + 7O_2 \rightarrow \boldsymbol{b}\ Fe_2O_3 + \boldsymbol{c}\ SO_2$$

Option	a	b	c
A	3	2	2
B	2	4	1
C	3	1	5
D	4	1	3
E	4	2	4

Question 464:
Magnesium consists of 3 isotopes: Mg^{23}, Mg^{25}, and Mg^{26} which are found naturally in a ratio of 80:10:10.
Calculate the relative atomic mass of magnesium.
A. 23.3
B. 23.4
C. 23.5
D. 23.6
E. 24.6

Question 465:
Consider the three reactions:

1. $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$
2. $Cu^{2+} + Mg \rightarrow Cu + Mg^{2+}$
3. $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Which of the following statements are correct?
A. Cl_2 and Fe_2O_3 are reducing agents.
B. CO and Cu^{2+} are oxidising agents.
C. Br_2 is a stronger oxidising agent than Cl_2.
D. Mg is a stronger reducing agent than Cu.
E. All of the above.

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Question 466:

Which row best describes the properties of NaCl?

A	High	Yes	Yes	Yes
B	High	No	Yes	No
C	High	Yes	No	Yes
D	High	No	No	No
E	Low	Yes	Yes	Yes

Question 467:

80 g of sodium hydroxide reacts with excess zinc nitrate to produce zinc hydroxide. Calculate the mass of zinc hydroxide produced. Relative atomic mass: N = 14, Zn = 65, O = 16, Na = 23.

A. 49 g
B. 95 g
C. 99 g
D. 100 g
E. 198 g

Question 468:

Which of the following statements is correct?

A. The reaction between all Group 1 metals and water is exothermic.
B. Sodium reacts less vigorously with water than potassium does.
C. All Group 1 metals react with water to produce elemental hydrogen.
D. All Group 1 metals react with water to produce a metal hydroxide.
E. All of the above.

Question 469:

Which of the following statements is correct?

A. NaCl can be separated using sieves.
B. CO_2 can be separated using electrolysis.
C. Dyes in a sample of ink can be separated using chromatography.
D. Oil and water can be separated using fractional distillation.
E. Methane and diesel can be separated using a separating funnel.

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Question 470:
Which of the following statements about the reaction between caesium and fluoride are correct?

1. It is an exothermic reaction and therefore requires catalysts.
2. It results in the formation of a salt.
3. The addition of water will make the reaction safer.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

Question 471:
Which of the following statements is generally true about stable isotopes?

1. The nucleus contains an equal number of neutrons and protons.
2. The nuclear charge is equal and opposite to the peripheral charge due to the orbiting electrons.
3. They can all undergo radioactive decay into more stable isotopes.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

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Question 472:

Why do most salts have very high melting temperatures?

A. Their surface is able to radiate away a significant portion of heat to the environment.
B. There are strong electrostatic attractions between the positive and negative ions.
C. The covalent bonds holding them together are very strong.
D. Their intermolecular forces are very strong.
E. All of the above.

Question 473:

A bottle of water contains 306ml of pure deionised water. How many protons are in the bottle from the water? Avogadro Constant = 6×10^{23}.

A. 1×10^{22}
B. 1×10^{23}
C. 1×10^{24}
D. 1×10^{25}
E. 1×10^{26}

Question 474:

On analysis, an organic substance is found to contain 41.4% carbon, 55.2% oxygen and 3.45% hydrogen by mass. Which of the following could be the empirical formula of this substance?

A. $C_3O_3H_6$
B. $C_3O_3H_{12}$
C. $C_4O_2H_4$
D. $C_4O_4H_4$
E. $C_4O_2H_8$

Question 475:

A is a Group 2 element and *B* is a Group 17 element. Which row best describes what happens when *A* reacts with *B*?

Option	B is	Formula
A	Reduced	AB
B	Reduced	A_2B
C	Reduced	AB_2
D	Oxidised	AB
E	Oxidised	A_2B

Question 476:

How many aliphatic structural isomers are there with the chemical formula $C_2H_4O_2$?

A. 10
B. 6
C. 8
D. 2
E. 4

Question 477:

Which of the following statements refers to a catalyst?

1. A species that is unused in a chemical reaction.
2. A species that lowers the activation energy of a reaction.
3. A species that moves the equilibrium position of a reaction.

A. 1 and 2
B. Only 1
C. Only 2
D. 1 and 3
E. Only 3

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Question 478:
What is role is $H^{\delta+}$ playing in the addition reaction of HBr over ethane to form Bromoethane?

A. A catalyst
B. A nucleophile
C. An electrophile
D. A Lewis base
E. None of the above

Question 479:
What are the conditions used in industry for the Haber process?
A. Room temperature, room pressure and an iron catalyst.
B. 450°C and room pressure.
C. 450°C, 200 atm pressure and an iron catalyst.
D. 450°C, 200 atm pressure and a platinum catalyst.
E. Room temperature, room pressure and a platinum catalyst.

Question 480:
A reversible forward reaction is exothermic. The forward reaction is the reaction that produces the desired product. Why in industry would a reaction like this sometimes be done under high temperatures?

A. To shift the equilibrium position in the forward direction, increasing the yield of product.
B. To shift the equilibrium position in the backwards direction, increasing the yield of product.
C. To keep the reaction rate high, increasing the yield of product over time.
D. To lower the activation energy of the reaction.
E. To make sure that the equilibrium position remains the same.

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Question 481:
Which of these reactions are oxidation/reduction reactions?

1. $Ca^{2+} + O^{2-} \rightarrow CaO$
2. $Ca + O \rightarrow CaO$
3. $2H_2O + Ca \rightarrow Ca(OH)_2 + H_2$
4. $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$

A. 1, 2 and 3
B. 1 and 2
C. 1, 3 and 4
D. 2 and 3
E. 2, 3 and 4

Question 482:
Which of the following is a reason for an increase in electronegativity for an atom in a covalent bond?

1. A smaller atomic radius.
2. A larger nuclear charge.
3. An increase in the number of neutrons in the nucleus.
4. More electron shells in-between the nucleus and outermost shell.
5. A smaller nuclear charge.

A. 1 and 2
B. 3, 4 and 5
C. 1 and 3
D. 1, 3 and 4
E. 2, 4 and 5

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Question 483:
Which of the following species will produce an amine when hydrogenated?

A. An aldehyde
B. An alkene
C. A nitrile
D. A ketone
E. A carboxylic acid

Question 484:
Which of the following species is in general the most susceptible to elimination?

A. A benzene ring
B. An alcohol
C. An iodide
D. A bromide
E. A chloride

Question 485:
Why do reactions where a species dissolves take place, when the reaction is exothermic?

A. The surroundings are hot.
B. There is a decrease in entropy after the reaction.
C. A reaction being exothermic has nothing to do with whether or not it will take place.
D. Overall Gibbs free energy is positive.
E. Overall Gibbs free energy is negative.

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Question 486:
In which reaction(s) is the species element A acting as a Lewis base?

1. $A^+ + B^- \rightarrow AB$
2. $A^- + B^+ \rightarrow AB$
3. $AB \rightarrow A^- + B^+$

A. Only 1
B. 1 and 2
C. Only 2
D. None
E. Only 3

Question 487:

What value of a balances the following equation: $4NH_3 + aO_2 \rightarrow bNO + cH_2O$

A. 2
B. 3
C. 4
D. 5
E. 6

Question 488:
What value of b balances the following equation if all the letters represent integers?
$aP_2I_4 + bP_4 + cH_2O \rightarrow dPH_4I + eH_3PO_4$

A. 13
B. 14
C. 15
D. 16
E. 17

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Question 489:
In the following reaction sequence, step 2 is the rate determining step for the overall reaction, what would the rate equation be?

- Step 1: A + B → C
- Step 2: 2C + D → E
- Step 3: E + D → F

A. k[A][B]
B. $k[A]^2[B]^2[D]$
C. $k[A]^2[B]^2$
D. $k[A]^2[B]^2[D][E]$
E. $k[C]^2[D]^2[E]$

Question 490:
Mike rubs a piece of wool with a balloon, he then places the wool next to a running tap of water and afterwards removes the wool and replaces it with the balloon. What does Mike observe?

A. Nothing.
B. The wool and balloon both cause the water stream to move away from them.
C. The wool causes the water stream to move closer to it, but the balloon causes the water stream to move away from it.
D. The wool and the balloon both cause the water stream to move towards them.
E. The wool causes the water to move away from it, but the balloon causes the water to move closer.

Question 491:
What is the strongest form of bonding listed?

A. Van der Waals
B. Hydrogen Bonding
C. Dipole-dipole attractions
D. Covalent
E. Ionic

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Question 492:
What would the bond angle between the two hydrogen-oxygen bonds in water be?

A. 104.5°
B. 90°
C. 109.5°
D. 120°
E. 107°

Question 493:
Which statement is correct?

A. Diamond is harder to melt than butane as diamond has stronger intermolecular forces.
B. Diamond is harder to melt than butane as in diamond, a covalent bond must be broken for it to melt, whereas in butane only weak intermolecular forces must be broken.
C. Diamond is harder to melt than butane as diamond is an ionic structure, whereas butane has a simple molecular structure.
D. Diamond is harder to melt than butane as diamond is a larger molecule than butane, so there are stronger Van der Waals forces between molecules in diamond than in butane.
E. Diamond is harder to melt than butane as it is chemically inert.

Question 494:
Which one of the following species is least prone to elimination?

A. A primary fluoroalkane
B. A tertiary fluoroalkane
C. A secondary fluoroalkane
D. A tertiary bromoalkane
E. A primary bromoalkane

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Question 495:
Consider the following reaction: $CH_2CHCH_3 + Br_2 \rightarrow CH_2BrCHBrCH_3$

In industry it is found that consistently there can be two different products with very different characteristics. What is the cause of this phenomenon?

A. One product isn't pure, the other is.
B. The product in this reaction breaks down into 2 different products.
C. The reaction doesn't actually take place, leaving the 2 reactants as they were.
D. One of the "products" is actually extra of one of the reactants left over from the reaction.
E. The product displays stereoisomerism.

Question 496:
But-2-ene has 2 forms even though their structural formula is the same. What phenomenon causes this to be the case?

A. A chiral carbon.
B. One of the carbons in the double bond has only 1 other functional group attached to it as well as the double bond.
C. Both carbons in the double bond have only 1 other functional group attached to them as well as the double bond.
D. The molecule has a dipole.
E. Both carbons in the double bond have 2 different functional groups attached to them as well as the double bond.

Question 497:
What is the molar mass of a metal that forms an oxide with the empirical formula M_2O_3 and contains 68% of the metal by mass? (A_r of O=16)

A. 50
B. 102
C. 51
D. 100
E. 68

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Question 498:
For the reaction represented by the equation $CX_4 + 2O_2 \rightarrow CO_2 + 2X_2O$

9.0 g of CX_4 completely reacts with 0.64 g of oxygen. What is the approximate molar mass of X?

A. 900
B. 888
C. 444
D. 222
E. 450

Question 499:
Pure oxygen can be made by heating a compound containing potassium, chlorine and oxygen.

What is the empirical formula of this compound, if a 4.1 g sample decomposes to give gaseous oxygen (O_2) and 2.5 g KCl? (A_r of O=16.0, K=39, Cl=36)

A. $KClO_3$
B. K_2ClO_3
C. KCl_2O_4
D. $KClO_4$
E. $K_2Cl_2O_3$

Question 500:
Which of the following is chiral (optically active)?

A. Bromochlorofluoromethane
B. Pent-2,3-diene
C. Hept-2,5-dien-4-ol
D. Benzene
E. Buckminsterfullerene

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SECTION 4: PHYSICS

If you haven't done physics at AS then you'll have to ensure that you are confident with commonly examined topics like Newtonian mechanics, electrical circuits and radioactive decay as you may not have covered these at GCSE depending on the specification you did.

The first step to improving in this section is to memorise all the equations listed on the next page.
The majority of the physics questions involve a fair bit of maths – this means you need to be comfortable with converting between units and also powers of 10. **Most questions require two step calculations**.

Consider the example:
A metal ball is released from the roof a 20-metre building. Assuming air resistance equals is negligible; calculate the velocity at which the ball hits the ground.
[$g = 10ms^{-2}$]
A. $5\ ms^{-1}$
B. $10\ ms^{-1}$
C. $15\ ms^{-1}$
D. $20\ ms^{-1}$
E. $25\ ms^{-1}$

When the ball hits the ground, all of its gravitational potential energy has been converted to kinetic energy. Thus, $E_p = E_k$:

$$mg\Delta h = \frac{mv^2}{2}$$

Thus, $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \sqrt{400} = 20ms^{-1}$

Here, you were required to not only recall two equations but apply and rearrange them very quickly to get the answer; all in under 60 seconds. Thus, it is easy to understand why the physics questions are generally much harder than the biology and chemistry ones.

Note that if you were comfortable with basic Newtonian mechanics, you could have also solved this using a single suvat equation: $v^2 = u^2 + 2as$

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$v = \sqrt{2 \times 10 \times 20} = 20 ms^{-1}$

This is why you're **strongly advised to learn the 'suvat' equations** on the next page even if they're technically not on the syllabus.

SI Units

Remember that in order to get the correct answer you must always work in SI units i.e. do your calculations in terms of metres (not centimetres) and kilograms (not grams), etc.

Top tip! Knowing SI units is extremely useful because they allow you to **work out equations** if you ever forget them e.g. The units for density are kg/m^3. Since kg is the SI unit for mass, and m^3 is represented by volume –the equation for density must be = Mass/Volume.

This can also work the other way, for example we know that the unit for Pressure is Pascal (Pa). But based on the fact that Pressure = Force/Area, a Pascal must be equivalent to N/m^2. Some physics questions will test your ability to manipulate units like this so it's important you are comfortable converting between them.

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Formulas you MUST know:

Factor	Text	Symbol
10^{12}	Tera	T
10^{9}	Giga	G
10^{6}	Mega	M
10^{3}	Kilo	k
10^{2}	Hecto	h
10^{-1}	Deci	d
10^{-2}	Centi	c
10^{-3}	Milli	m
10^{-6}	Micro	μ
10^{-9}	Nano	n
10^{-12}	Pico	p

Equations of Motion:

- $s = ut + 0.5at^2$
- $v = u + at$
- $a = (v-u)/t$
- $v^2 = u^2 + 2as$

Equations relating to Force:

- Force = mass x acceleration
- Force = Momentum/Time
- Pressure = Force / Area
- Moment of a Force = Force x Distance
- Work done = Force x Displacement

For objects in equilibrium:

- Sum of Clockwise moments = Sum of Anti-clockwise moments
- Sum of all resultant forces = 0

Electrical Equations:

- $Q = It$
- $V = IR$
- $P = IV = I^2R = V^2/R$
- V = Potential difference (V, Volts)
- R = Resistance (Ohms)
- P = Power (W, Watts)
- Q = Charge (C, Coulombs)
- t= Time (s, seconds)

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Equations relating to Energy:

- Kinetic Energy = 0.5 mv^2
- Δ in Gravitational Potential Energy = $mg\Delta h$
- Energy Efficiency = (Useful energy/ Total energy) x 100%

Equations relating to Power:

- Power = Work done / time
- Power = Energy transferred / time
- Power = Force x velocity

For Transformers:

- $\frac{V_p}{V_s} = \frac{n_p}{n_s}$ where:
- V: Potential difference
- *n*: Number of turns
- *p*: Primary
- *s*: Secondary

Other:

- Weight = mass x *g*
- Density = Mass / Volume
- Momentum = Mass x Velocity
- *g* = 9.81 ms^{-2} (unless otherwise stated)

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PHYSICS QUESTIONS

Question 501:

Which of the following statements are **FALSE**?

A. Electromagnetic waves cause things to heat up.
B. X-rays and gamma rays can knock electrons out of their orbits.
C. Loud sounds can make objects vibrate.
D. Wave power can be used to generate electricity.
E. The amplitude of a wave determines its mass.

Question 502:

A spacecraft is analysing a newly discovered exoplanet. A rock of unknown mass falls on the planet from a height of 30 m. Given that g = 5.4 ms^{-2} on the planet, calculate the speed of the rock when it hits the ground and the time it took to fall.

Option	Speed (ms^{-1})	Time (s)
A	18	3.3
B	18	3.1
C	12	3.3
D	10	3.7
E	9	2.3

Question 503:

A canoe floating on the sea rises and falls 7 times in 49 seconds. The waves pass it at a speed of
5 ms^{-1}. How long are the waves?

A. 12 m
B. 22 m
C. 25 m
D. 35 m
E. 57 m

Question 504:

Miss Orrell lifts her 37.5 kg bike for a distance of 1.3 m in 5 s. The acceleration of free fall is 10 ms^{-2}. What is the average power that she develops?

A. 9.8 W
B. 12.9 W
C. 57.9 W
D. 79.5 W
E. 97.5W

Question 505:

A truck accelerates at 5.6 ms^{-2} from rest for 8 seconds. Calculate the final speed and the distance travelled in 8 seconds.

Option	Final Speed (ms^{-1})	Distance (m)
A	40.8	119.2
B	40.8	129.6
C	42.8	179.2
D	44.1	139.2
E	44.8	179.2

Question 506:

Which of the following statements is true when a sky diver jumps out of a plane?

A. The sky diver leaves the plane and will accelerate until the air resistance is greater than their weight.
B. The sky diver leaves the plane and will accelerate until the air resistance is less than their weight.
C. The sky diver leaves the plane and will accelerate until the air resistance equals their weight.
D. The sky diver leaves the plane and will accelerate until the air resistance equals their weight squared.
E. The sky diver will travel at a constant velocity after leaving the plane.

Question 507:
A 100 g apple falls on Isaac's head from a height of 20 m. Calculate the apple's momentum before the point of impact. Take g = 10 ms^{-2}

A. 0.1 $kgms^{-1}$
B. 0.2 $kgms^{-1}$
C. 1 $kgms^{-1}$
D. 2 $kgms^{-1}$
E. 10 $kgms^{-1}$

Question 508:
Which of the following do all electromagnetic waves all have in common?

1. They can travel through a vacuum.
2. They can be reflected.
3. They are the same length.
4. They have the same amount of energy.
5. They can be polarised.

A. 1, 2 and 3
B. 1, 2, 3 and 4
C. 4 and 5
D. 3 and 4
E. 1, 2 and 5

Question 509:
A battery with an internal resistance of 0.8 Ω and e.m.f of 36 V is used to power a drill with resistance 1 Ω. What is the current in the circuit when the drill is connected to the power supply?

A. 5 A
B. 10 A
C. 15 A
D. 20 A
E. 25 A

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Question 510:
Officer Bailey throws a 20 g dart at a speed of 100 ms^{-1}. It strikes the dartboard and is brought to rest in 10 milliseconds. Calculate the average force exerted on the dart by the dartboard.

A. 0.2 N
B. 2 N
C. 20 N
D. 200 N
E. 2,000 N

Question 511:
Professor Huang lifts a 50 kg bag through a distance of 0.7 m in 3 s. What average power does she develop to 3 significant figures? Take $g = 10ms^{-2}$

A. 112 W
B. 113 W
C. 114 W
D. 115 W
E. 117 W

Question 512:
An electric scooter is travelling at a speed of 30 ms^{-1} and is kept going against a 50 N frictional force by a driving force of 300 N in the direction of motion. Given that the engine runs at 200 V, calculate the current in the scooter.

A. 4.5 A
B. 45 A
C. 450 A
D. 4,500 A
E. 45,000 A

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Question 513:

Which of the following statements about the physical definition of work are correct?

1. Work done = Force/Distance
2. The unit of work is equivalent to $Kgms^{-2}$.
3. Work is defined as a force causing displacement of the body upon which it acts.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 514:

Which of the following statements about kinetic energy are correct?

1. It is defined as $E_k = \frac{mv^2}{2}$
2. The unit of kinetic energy is equivalent to Pa x m^3.
3. Kinetic energy is equal to the amount of energy needed to decelerate the body in question from its current speed.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

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Question 515:

In relation to radiation, which of the following statements is **FALSE**?

A. Radiation is the emission of energy in the form of waves or particles.
B. Radiation can be either ionizing or non-ionizing.
C. Gamma radiation has very high energy.
D. Alpha radiation is of higher energy than beta radiation.
E. X-rays are an example of wave radiation.

Question 516:

In relation to the physical definition of half-life, which of the following statements are correct?

1. In radioactive decay, the half-life is independent of atom type and isotope.
2. Half-life is defined as the time required for exactly half of the entities to decay.
3. Half-life applies to situations of both exponential and non-exponential decay.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 517:

In relation to nuclear fusion, which of the following statements is **FALSE**?

A. Nuclear fusion is initiated by the absorption of neutrons.
B. Nuclear fusion describes the fusion of hydrogen atoms to form helium atoms.
C. Nuclear fusion releases great amounts of energy.
D. Nuclear fusion requires high activation temperatures.
E. All of the statements above are false.

Question 518:

In relation to nuclear fission, which of the following statements is correct?

A. Nuclear fission is the basis of many nuclear weapons.
B. Nuclear fission is triggered by the shooting of neutrons at unstable atoms.
C. Nuclear fission can trigger chain reactions.
D. Nuclear fission commonly results in the emission of ionizing radiation.
E. All of the above.

Question 519:

Two identical resistors (R_a and R_b) are connected in a series circuit. Which of the following statements are true?

1. The current through both resistors is the same.
2. The voltage through both resistors is the same.
3. The voltage across the two resistors is given by Ohm's Law.

A. 1 only
B. 2 only
C. 3 only
D. 1, 2 and 3
E. None

Question 520:

The Sun is 8 light-minutes away from the Earth. Estimate the circumference of the Earth's orbit around the Sun. Assume that the Earth is in a circular orbit around the Sun. Speed of light = 3×10^8 ms^{-1}

A. 10^{24} m
B. 10^{21} m
C. 10^{18} m
D. 10^{15} m
E. 10^{12} m

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Question 521:

Which of the following statements about the physical definition of speed are true?

1. Speed is the same as velocity.
2. The internationally standardised unit for speed is ms^{-2}.
3. Velocity = distance/time.

A. 1 only
B. 2 only
C. 3 only
D. 1, 2 and 3
E. None

Question 522:

Which of the following statements best defines Ohm's Law?

A. The current through an insulator between two points is indirectly proportional to the potential difference across the two points.
B. The current through an insulator between two points is directly proportional to the potential difference across the two points.
C. The current through a conductor between two points is inversely proportional to the potential difference across the two points.
D. The current through a conductor between two points is proportional to the square of the potential difference across the two points.
E. The current through a conductor between two points is directly proportional to the potential difference across the two points.

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Question 523:

Which of the following statements regarding Newton's Second Law are correct?

1. For objects at rest, resultant force must be 0 Newtons
2. Force = Mass x Acceleration
3. Force = rate of change of momentum

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

Question 524:

Which of the following equations concerning electrical circuits are correct?

1. $\text{Charge} = \frac{\text{Voltage x Time}}{\text{Resistance}}$
2. $\text{Charge} = \frac{\text{Power x Time}}{\text{Voltage}}$
3. $\text{Charge} = \frac{\text{Current x Time}}{\text{Resistance}}$

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 525:
An elevator has a mass of 1,600 kg and is carrying passengers that have a combined mass of 200 kg. A constant frictional force of 4,000 N works against its motion upward. What force must the motor provide for the elevator to move with an upward acceleration of 1 ms^{-2}? Assume: g = 10 ms^{-2}

A. 1,190 N
B. 11,900 N
C. 18,000 N
D. 22,000 N
E. 23,800 N

Question 526:
A 1,000 kg car accelerates from rest at 5 ms^{-2} for 10 s. Then, a braking force is applied to bring it to rest within 20 seconds. What distance has the car travelled?

A. 125m
B. 250m
C. 650m
D. 750m
E. 1,200 m

Question 527:
An electric heater is connected to 120 V mains by a copper wire that has a resistance of 8 ohms. What is the power of the heater?

A. 90 W
B. 180 W
C. 900 W
D. 1800 W
E. More information needed

Question 528:

In a particle accelerator, electrons are accelerated through a potential difference of 40 MV and emerge with an energy of 40MeV (1 MeV = 1.60×10^{-13} J). Each pulse contains 5,000 electrons. The current is zero between pulses. Assuming that the electrons have zero energy prior to being accelerated what is the power delivered by the electron beam?

A. 1 kW
B. 10 kW
C. 100 kW
D. 1,000 kW
E. More information needed

Question 529:

Which of the following statements is **true**?

A. When an object is in equilibrium with its surroundings, there is no energy transferred to or from the object and so its temperature remains constant.
B. When an object is in equilibrium with its surroundings, it radiates and absorbs energy at the same rate and so its temperature remains constant.
C. Radiation is faster than convection but slower than conduction.
D. Radiation is faster than conduction but slower than convection.
E. None of the above.

Question 530:

A 6kg block is pulled from rest along a horizontal frictionless surface by a constant horizontal force of 12 N. Calculate the speed of the block after it has moved 300 cm.

A. $2\sqrt{3}$ ms^{-1}
B. $4\sqrt{3}$ ms^{-1}
C. $4\sqrt{3}$ ms^{-1}
D. 12 ms^{-1}
E. $\sqrt{\frac{3}{2}}$ ms^{-1}

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Question 531:
A 100 V heater heats 1.5 litres of pure water from 10◦C to 50◦C in 50 minutes. Given that 1 kg of pure water requires 4,000 J to raise its temperature by 1◦C, calculate the resistance of the heater.

A. 12.5 ohms
B. 25 ohms
C. 125 ohms
D. 250 ohms
E. 500 ohms

Question 532:
Which of the following statements are **true**?

1. Nuclear fission is the basis of nuclear energy.
2. Following fission, the resulting atoms are a different element to the original one.
3. Nuclear fission often results in the production of free neutrons and photons.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

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Question 533:
Which of the following statements are **true**? Assume $g = 10\ ms^{-2}$.

1. Gravitational potential energy is defined as $\Delta E_p = m \times g \times \Delta h$.
2. Gravitational potential energy is a measure of the work done against gravity.
3. A reservoir situated 1 km above ground level with 10^6 litres of water has a potential energy of 1 Giga Joule.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. None of the above

Question 534:
Which of the following statements are correct in relation to Newton's 3rd law?

1. For every action there is an equal and opposite reaction.
2. According to Newton's 3rd law, there are no isolated forces.
3. Rockets cannot accelerate in deep space because there is nothing to generate an equal and opposite force.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 535:

Which of the following statements are correct?

1. Positively charged objects have gained electrons.
2. Electrical charge in a circuit over a period of time can be calculated if the voltage and resistance are known.
3. Objects can be charged by friction.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 536:

Which of the following statements is true?

A. The gravitational force between two objects is independent of their mass.
B. Each planet in the solar system exerts a gravitational force on the Earth.
C. For satellites in a geostationary orbit, acceleration due to gravity is equal and opposite to the lift from engines.
D. Two objects that are dropped from the Eiffel tower will always land on the ground at the same time if they have the same mass.
E. All of the above.

Question 537:

Which of the following best defines an electrical conductor?

A. Conductors are usually made from metals and they conduct electrical charge in multiple directions.
B. Conductors are usually made from non-metals and they conduct electrical charge in multiple directions.
C. Conductors are usually made from metals and they conduct electrical charge in one fixed direction.
D. Conductors are usually made from non-metals and they conduct electrical charge in one fixed direction.
E. Conductors allow the passage of electrical charge with zero resistance because they contain freely mobile charged particles.

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Question 538:
An 800 kg compact car delivers 20% of its power output to its wheels. If the car has a mileage of 30 miles/gallon and travels at a speed of 60 miles/hour, how much power is delivered to the wheels?
1 gallon of petrol contains 9×10^8 J.

A. 10 kW
B. 20 kW
C. 40 kW
D. 50 kW
E. 100 kW

Question 539:
Which of the following statements about beta radiation are true?

1. After a beta particle is emitted, the atomic mass number is unchanged.
2. Beta radiation can penetrate paper but not aluminium foil.
3. A beta particle is emitted from the nucleus of the atom when an electron changes into a neutron.

A. 1 only
B. 2 only
C. 1 and 3
D. 1 and 2
E. 2 and 3

Question 540:
A car with a weight of 15,000 N is travelling at a speed of 15 ms^{-1} when it crashes into a wall and is brought to rest in 10 milliseconds. Calculate the average braking force exerted on the car by the wall. Take $g = 10$ ms^{-2}

A. 1.25×10^4N
B. 1.25×10^5N
C. 1.25×10^6N
D. 2.25×10^4N
E. 2.25×10^5N

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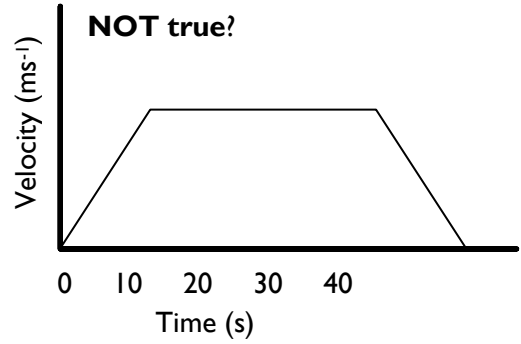
Question 541:
Which of the following statements are correct?

1. Electrical insulators are usually metal e.g. copper.
2. The flow of charge through electrical insulators is extremely low.
3. Electrical insulators can be charged by rubbing them together.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

The following information is needed for Questions 542 and 543:
The graph below represents a car's movement. At t=0 the car's displacement was 0 m.

Question 542:
Which of the following statements are **NOT true**?



1. The car is reversing after t = 30.
2. The car moves with constant acceleration from t = 0 to t = 10.
3. The car moves with constant speed from t = 10 to t = 30.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1 and 2

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Question 543:
Calculate the distance travelled by the car.

A. 200 m
B. 300 m
C. 350 m
D. 400 m
E. 500 m

Question 544:
A 1,000 kg rocket is launched during a thunderstorm and reaches a constant velocity 30 seconds after launch. Suddenly, a strong gust of wind acts on it for 5 seconds with a force of 10,000 N in the direction of movement.
What is the resulting change in velocity?

A. 0.5 ms^{-1}
B. 5 ms^{-1}
C. 50 ms^{-1}
D. 500 ms^{-1}
E. 5000 ms^{-1}

Question 545:
A 0.5 tonne crane lifts a 0.01 tonne wardrobe by 100 cm in 5,000 milliseconds. Calculate the average power developed by the crane. Take g = 10 ms^{-2}.

A. 0.2 W
B. 2 W
C. 5 W
D. 20 W
E. 50 W

Question 546:

A 20 V battery is connected to a circuit consisting of a 1 Ω and 2 Ω resistor in parallel. Calculate the overall current of the circuit.

A. 6.67 A
B. 8 A
C. 10 A
D. 12 A
E. 30 A

Question 547:

Which of the following statements is correct?

A. The speed of light changes when it enters water.
B. The speed of light changes when it leaves water.
C. The direction of light changes when it enters water.
D. The direction of light changes when it leaves water.
E. All of the above.

Question 548:

In a parallel circuit, a 60 V battery is connected to two branches. Branch *A* contains 6 identical 5 Ω resistors and branch *B* contains 2 identical 10 Ω resistors.

Calculate the current in branches *A* and *B*.

Option	I_A (A)	I_B (A)
A	0	6
B	6	0
C	2	3
D	3	2
E	3	3

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Question 549:
Calculate the voltage of an electrical circuit that has a power output of 50,000,000,000 nW and a current of 0.000 000 004 GA.

A. 0.0125 GV
B. 0.0125 MV
C. 0.0125 kV
D. 0.0125 V
E. 0.0125 mV

Question 550:
Which of the following statements about radioactive decay is correct?
A. Radioactive decay is highly predictable.
B. An unstable element will continue to decay until it reaches a stable nuclear configuration.
C. All forms of radioactive decay release gamma rays.
D. All forms of radioactive decay release X-rays.
E. An atom's nuclear charge is unchanged after it undergoes alpha decay.

Question 551:
A circuit contains three identical resistors of unknown resistance connected in series with a 15 V battery. The power output of the circuit is 60 W. Calculate the overall resistance of the circuit when two further identical resistors are added to it.

A. 0.125 Ω
B. 1.25 Ω
C. 3.75 Ω
D. 6.25 Ω
E. 18.75 Ω

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Question 552:

A 5,000 kg tractor's engine uses 1 litre of fuel to move 0.1 km. 1 ml of the fuel contains 20 kJ of energy.

Calculate the engine's efficiency. Take $g = 10\ ms^{-2}$

A. 2.5 %
B. 25 %
C. 38 %
D. 50 %
E. More information needed.

Question 553:

Which of the following statements are correct?

1. Electromagnetic induction occurs when a wire moves relative to a magnet.
2. Electromagnetic induction occurs when a magnetic field changes.
3. An electrical current is generated when a coil rotates in a magnetic field.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

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Question 554:
Which of the following statements are correct regarding parallel circuits?

1. The current flowing through a branch is dependent on the branch's resistance.
2. The total current into the branches is equal to the total current out of the branches.
3. An ammeter will always give the same reading regardless of its location in the circuit.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

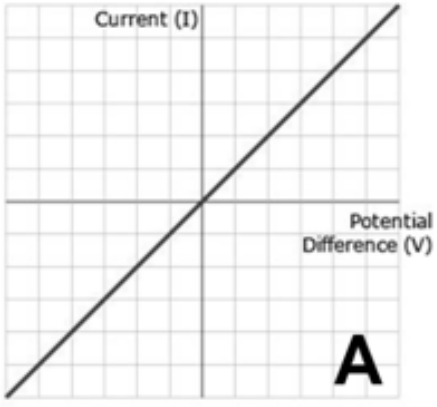
Question 555:
Which of the following statements regarding series circuits are true?

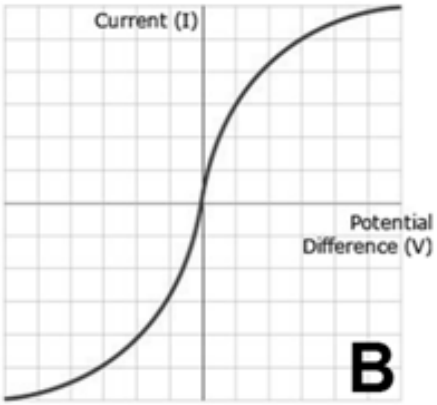
1. The overall resistance of a circuit is given by the sum of all resistors in the circuit.
2. Electrical current moves from the positive terminal to the negative terminal.
3. Electrons move from the positive terminal to the negative terminal.

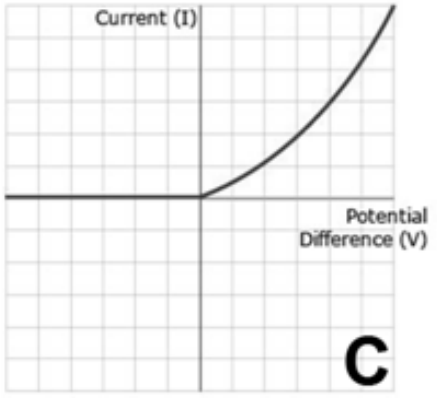
A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

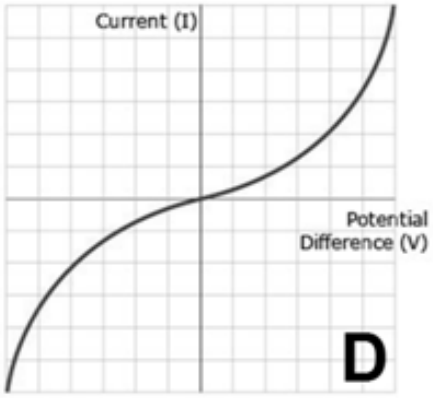
Question 556:

The graphs below show current vs. voltage plots for 4 different electrical components:









Which of the following graphs represents a resistor at constant temperature, and which a filament lamp?

Option	Fixed Resistor	Filament Lamp
A	A	B
B	A	C
C	A	D
D	C	A
E	C	C

Question 557:
Which of the following statements are true about vectors?
A. Vectors can be added or subtracted.
B. All vector quantities have a defined magnitude.
C. All vector quantities have a defined direction.
D. Displacement is an example of a vector quantity.
E. All of the above.

Question 558:
The acceleration due to gravity on the Earth is six times greater than that on the moon. Dr Tyson records the weight of a rock as 250 N on the moon.

Calculate the rock's density given that it has a volume of 250 cm^3. Take g_{Earth} = 10 ms^{-2}

A. 0.2 kg/cm^3
B. 0.5 kg/cm^3
C. 0.6 kg/cm^3
D. 0.7 kg/cm^3
E. 0.8 kg/cm^3

Question 559:
A radioactive element X_{78}^{225} undergoes alpha decay. What is the atomic mass and atomic number after 5 alpha particles have been released?

Option	Mass Number	Atomic Number
A	200	56
B	200	58
C	205	64
D	205	68
E	215	58

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Question 560:

A 20 A current passes through a circuit with resistance of 10 Ω. The circuit is connected to a transformer that contains a primary coil with 5 turns and a secondary coil with 10 turns. Calculate the potential difference exiting the transformer.

A. 100 V
B. 200 V
C. 400 V
D. 500 V
E. 2,000 V

Question 561:

A metal sphere of unknown mass is dropped from an altitude of 1 km and reaches terminal velocity 300 m before it hits the ground. Given that resistive forces do a total of 10 kJ of work for the last 100 m before the ball hits the ground, calculate the mass of the ball. Take $g = 10ms^{-2}$.

A. 1 kg
B. 2 kg
C. 5 kg
D. 10 kg
E. 20 kg

Question 562:

Which of the following statements is true about the electromagnetic spectrum?

A. The wavelength of ultraviolet waves is shorter than that of x-rays.
B. For waves in the electromagnetic spectrum, wavelength is directly proportional to frequency.
C. Most electromagnetic waves can be stopped with a thin layer of aluminium.
D. Waves in the electromagnetic spectrum travel at the speed of sound.
E. None of the above.

Question 563:
In relation to the Doppler Effect, which of the following statements are true?

1. If an object emitting a wave moves towards the sensor, the wavelength increases and frequency decreases.
2. An object that originally emitted a wave of a wavelength of 20 mm, followed by a second reading delivering a wavelength of 15 mm, is moving towards the sensor.
3. The faster the object is moving away from the sensor, the greater the increase in frequency.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 564:
A 5 g bullet is travelling at 1 km/s and hits a brick wall. It penetrates 50 cm before being brought to rest 100 ms after impact. Calculate the average braking force exerted by the wall on the bullet.

A. 50 N
B. 500 N
C. 5,000 N
D. 50,000 N
E. 500,000 N

Question 565:
Polonium (Po) is a highly radioactive element that has no known stable isotope. Po^{210} undergoes radioactive decay to Pb^{206} and Y. Calculate the number of protons in 10 moles of *Y*. (Avogadro's Constant = 6×10^{23})

A. 0
B. 1.2×10^{24}
C. 1.2×10^{25}
D. 2.4×10^{24}
E. 2.4×10^{25}

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Question 566:

Dr Sale measures the background radiation in a nuclear wasteland to be 1,000 Bq. He then detects a spike of 16,000 Bq from a nuclear rod made up of an unknown material. 300 days later, he visits and can no longer detect a reading higher than 1,000 Bq from the rod, even though it hasn't been disturbed.

What is the longest possible half-life of the nuclear rod?

A. 25 days
B. 50 days
C. 75 days
D. 100 days
E. 150 days

Question 567:

A radioactive element Y_{89}^{200} undergoes a series of beta (β^-) and gamma decays. What are the number of protons and neutrons in the element after the emission of 5 beta particles and 2 gamma waves?

Option	Protons	Neutrons
A	79	101
B	84	111
C	84	116
D	89	111
E	109	111

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Question 568:
Most symphony orchestras tune to 'standard pitch' (frequency = 440 Hz). When they are tuning, sound directly from the orchestra reaches audience members that are 500 m away in 1.5 seconds.
Estimate the wavelength of 'standard pitch'.

A. 0.05 m
B. 0.5 m
C. 0.75 m
D. 1.5 m
E. 15 m

Question 569:
A 1 kg cylindrical artillery shell with a radius of 50 mm is fired at a speed of 200 ms^{-1}. It strikes an armour-plated wall and is brought to rest in 500 μs.

Calculate the average pressure exerted on the entire shell by the wall at the time of impact.

A. 5×10^6 Pa
B. 5×10^7 Pa
C. 5×10^8 Pa
D. 5×10^9 Pa
E. 5×10^{10} Pa

Question 570:
A 1,000 W display fountain launches 120 litres of water straight up every minute. Given that the fountain is 10% efficient, calculate the maximum possible height that the stream of water could reach.
Assume that there is negligible air resistance and g = 10 ms^{-2}.

A. 1 m
B. 5 m
C. 10 m
D. 20 m
E. 50m

Question 571:
In relation to transformers, which of the following is true?

1. Step up transformers increase the voltage leaving the transformer.
2. In step down transformers, the number of turns in the primary coil is smaller than in the secondary coil.
3. For transformers that are 100% efficient: $I_p V_p = I_s V_s$

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 572:
The half-life of Carbon-14 is 5,730 years. A bone is found that contains 6.25% of the amount of C^{14} that would be found in a modern one. How old is the bone in years?

A. 11,460
B. 17,190
C. 22,920
D. 28,650
E. 34,380

Question 573:
A wave has a velocity of 2,000 mm/s and a wavelength of 250 cm. What is its frequency in MHz?

A. 8×10^{-3}
B. 8×10^{-4}
C. 8×10^{-5}
D. 8×10^{-6}
E. 8×10^{-7}

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Question 574:
A radioactive element has a half-life of 25 days. After 350 days it has a count rate of 50. What was its original count rate?

A. 102,400
B. 162,240
C. 204,800
D. 409,600
E. 819,200

Question 575:
Which of the following units is **NOT** equivalent to a Volt (V)?

A. AΩ
B. WA^{-1}
C. $Nms^{-1}A^{-1}$
D. NmC
E. J / C

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SECTION 4: MATHS

IMAT Maths questions are designed to be time draining – if you find yourself consistently not finishing, it might be worth leaving the maths (and probably physics) questions until the very end. Good students sometimes have a habit of making easy questions difficult; remember that the IMAT only tests school level knowledge so you are not expected to know or use calculus or advanced trigonometry in any part of the exam.

2D Shapes Area	
Circle	πr^2
Parallelogram	Base x Vertical height
Trapezium	0.5 x h x (a + b)
Triangle	0.5 x base x height

3D Shapes		
	Surface Area	**Volume**
Cuboid	Sum of all 6 faces	Length x width x height
Cylinder	$2\pi r^2 + 2\pi rl$	$\pi r^2 \times l$
Cone	$\pi r^2 + \pi rl$	$\pi r^2 \times (h/3)$
Sphere	$4\pi r^2$	$(4/3)\pi r^3$

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Formulas you **MUST** know:

Even good students who are studying maths at A2 can struggle with certain IMAT maths topics because they're usually glossed over at school. These include:

Quadratic Formula

The solutions for a quadratic equation in the form $ax^2 + bx + c = 0$ are given by: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Remember that you can also use the discriminant to quickly see if a quadratic equation has any solutions:

- If $b^2 - 4ac < 0$: No solutions
- If $b^2 - 4ac = 0$: One solution
- If $b^2 - 4ac > 2$: Two solutions

Completing the Square

If a quadratic equation cannot be factorised easily and is in the format $ax^2 + bx + c = 0$ then you can rearrange it into the form $a\left(x+\frac{b}{2a}\right)^2 + [c-\frac{b^2}{4a}]=0$

This looks more complicated than it is – remember that in the IMAT, you're extremely unlikely to get quadratic equations where $a > 1$ and the equation doesn't have any easy factors.

This gives you an easier equation: $\left(x + \frac{b}{2}\right)^2 + \left[c - \frac{b^2}{4}\right]=0$ and is best understood with an example.

Consider: $x^2 + 6x + 10 = 0$

This equation cannot be factorised easily but note that: $x^2 + 6x - 10 = (x + 3)^2 - 19 = 0$

Thus, $x = -3 \pm \sqrt{19}$. Completing the square is an important skill – make sure you're comfortable with it.

Difference between 2 Squares

If you are asked to simplify expressions and find that there are no common factors, but it involves square numbers – you might be able to factorise by using the 'difference between two squares'. For example, $x^2 - 25$ can also be expressed as $(x + 5)(x - 5)$.

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MATHS QUESTIONS

Question 576:

Robert has a box of building blocks. The box contains 8 yellow blocks and 12 red blocks. He picks three blocks from the box and stacks them up high. Calculate the probability that he stacks two red building blocks and one yellow building block, in **any** order.

A. $\frac{8}{20}$
B. $\frac{44}{95}$
C. $\frac{11}{18}$
D. $\frac{8}{19}$
E. $\frac{12}{20}$

Question 577:

Solve $\frac{3x+5}{5} + \frac{2x-2}{3} = 18$

A. 12.11
B. 13.49
C. 13.95
D. 14.2
E. 19

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Question 578:

Solve $3x^2 + 11x - 20 = 0$

A. 0.75 and $-\frac{4}{3}$
B. -0.75 and $\frac{4}{3}$
C. -5 and $\frac{4}{3}$
D. 5 and $\frac{4}{3}$
E. 12 only

Question 579:

Express $\frac{5}{x+2} + \frac{3}{x-4}$ as a single fraction.

A. $\frac{15x - 120}{(x+2)(x-4)}$
B. $\frac{8x - 26}{(x+2)(x-4)}$
C. $\frac{8x - 14}{(x+2)(x-4)}$
D. $\frac{15}{8x}$
E. 24

Question 580:

The value of p is directly proportional to the cube root of q. When p = 12, q = 27. Find the value of q when p = 24.

A. 32
B. 64
C. 124
D. 128
E. 216

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Question 581:

Write 72^2 as a product of its prime factors.

A. $2^6 \times 3^4$
B. $2^6 \times 3^5$
C. $2^4 \times 3^4$
D. 2×3^3
E. $2^6 \times 3$

Question 582:

Calculate: $\frac{2.302 \times 10^5 + 2.302 \times 10^2}{1.151 \times 10^{10}}$

A. 0.0000202
B. 0.00020002
C. 0.00002002
D. 0.00000002
E. 0.000002002

Question 583:

Given that $y^2 + \mathbf{a}y + \mathbf{b} = (y + 2)^2 - 5$, find the values of **a** and **b**.

Option	a	b
A	-1	4
B	1	9
C	-1	-9
D	-9	1
E	4	-1

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Question 584:

Express $\frac{4}{5} + \frac{m - 2n}{m + 4n}$ as a single fraction in its simplest form:

A. $\frac{6m + 6n}{5\,(m + 4n)}$

B. $\frac{9m + 26n}{5\,(m + 4n)}$

C. $\frac{20m + 6n}{5\,(m + 4n)}$

D. $\frac{3m + 9n}{5\,(m + 4n)}$

E. $\frac{3\,(3m + 2n)}{5\,(m + 4n)}$

Question 585:

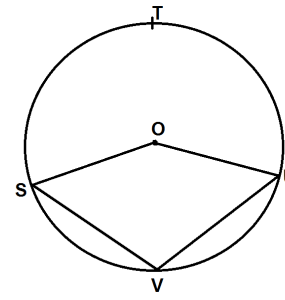
A is inversely proportional to the square root of B. When A = 4, B = 25.
Calculate the value of A when B = 16.

A. 0.8
B. 4
C. 5
D. 6
E. 10

Question 586:

S, T, U and V are points on the circumference of a circle, and O is the centre of the circle.

Given that angle SVU = 89°, calculate the size of the smaller angle SOU.



A. 89°
B. 91°
C. 102°
D. 178°
E. 182°

Question 587:

Open cylinder A has a surface area of 8π cm^2 and a volume of 2π cm^3. Open cylinder B is an enlargement of A and has a surface area of 32π cm^2. Calculate the volume of cylinder B.

A. 2π cm^3
B. 8π cm^3
C. 10π cm^3
D. 14π cm^3
E. 16π cm^3

Question 588:

Express $\frac{8}{x(3-x)} - \frac{6}{x}$ in its simplest form.

A. $\frac{3x-10}{x(3-x)}$
B. $\frac{3x+10}{x(3-x)}$
C. $\frac{6x-10}{x(3-2x)}$
D. $\frac{6x-10}{x(3+2x)}$
E. $\frac{6x-10}{x(3-x)}$

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Question 589:
A bag contains 10 balls. 9 of those are white and 1 is black. What is the probability that the black ball is drawn in the tenth and final draw if the drawn balls are not replaced?

A. $\frac{1}{9}$
B. $\frac{1}{10}$
C. $\frac{1}{100}$
D. $\frac{1}{10^{10}}$
E. $\frac{1}{362,880}$

Question 590:
Gambit has an ordinary deck of 52 cards. What is the probability of Gambit drawing 2 Kings (without replacement)?

A. 0
B. $\frac{1}{169}$
C. $\frac{1}{221}$
D. $\frac{4}{663}$
E. None of the above

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Question 591:

I have two identical unfair dice, where the probability that the dice get a 6 is twice as high as the probability of any other outcome, which are all equally likely. What is the probability that when I roll both dice the total will be 12?

A. 0
B. $\frac{4}{49}$
C. $\frac{1}{9}$
D. $\frac{2}{7}$
E. None of the above

Question 592:

A roulette wheel consists of 36 numbered spots and 1 zero spot (i.e. 37 spots in total).

What is the probability that the ball will stop in a spot either divisible by 3 or 2?

A. $\frac{6}{37}$
B. $\frac{25}{37}$
C. $\frac{25}{36}$
D. $\frac{18}{37}$
E. $\frac{24}{37}$

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Question 593:
I have a fair coin that I flip 4 times. What is the probability I get 2 heads and 2 tails?

A. $\frac{1}{16}$
B. $\frac{3}{16}$
C. $\frac{3}{8}$
D. $\frac{9}{16}$
E. None of the above

Question 594:
Shivun rolls two fair dice. What is the probability that he gets a total of 5, 6 or 7?

A. $\frac{9}{36}$
B. $\frac{7}{12}$
C. $\frac{1}{6}$
D. $\frac{5}{12}$
E. None of the above

Question 595:
Dr Savary has a bag that contains x red balls, y blue balls and z green balls (and no others). He pulls out a ball, replaces it, and then pulls out another. What is the probability that he picks one red ball and one green ball?

A. $\frac{2(x+y)}{x+y+z}$
B. $\frac{xz}{(x+y+z)^2}$
C. $\frac{2xz}{(x+y+z)^2}$
D. $\frac{(x+z)}{(x+y+z)^2}$
E. $\frac{4xz}{(x+y+z)^4}$

Question 596:
Mr Kilbane has a bag that contains x red balls, y blue balls and z green balls (and no others). He pulls out a ball, does **NOT** replace it, and then pulls out another. What is the probability that he picks one red ball and one blue ball?

A. $\frac{2xy}{(x+y+z)^2}$
B. $\frac{2xy}{(x+y+z)(x+y+z-1)}$
C. $\frac{2xy}{(x+y+z)^2}$
D. $\frac{xy}{(x+y+z)(x+y+z-1)}$
E. $\frac{4xy}{(x+y+z-1)^2}$

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Question 597:

There are two tennis players. The first player wins the point with probability p, and the second player wins the point with probability 1 - p. The rules of tennis say that the first player to score four points wins the game, unless the score is 4-3. At this point the first player to get two points ahead wins.

What is the probability that the first player wins in exactly 5 rounds?

A. $4p^4 (1 - p)$
B. $p^4 (1 - p)$
C. $4p (1 - p)$
D. $4p (1 - p)^4$
E. $4p^5 (1 - p)$

Question 598:

Solve the equation $\frac{4x + 7}{2} + 9x + 10 = 7$.

A. $\frac{22}{13}$
B. $-\frac{22}{13}$
C. $\frac{10}{13}$
D. $-\frac{10}{13}$
E. $-\frac{13}{22}$

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Question 599:

The volume of a sphere is $V = \frac{4}{3}\pi r^3$, and the surface area of a sphere is $S = 4\pi r^2$. Express S in terms of V.

A. $S = (4\pi)^{2/3}(3V)^{2/3}$
B. $S = (8\pi)^{1/3}(3V)^{2/3}$
C. $S = (4\pi)^{1/3}(9V)^{2/3}$
D. $S = (4\pi)^{1/3}(3V)^{2/3}$
E. $S = (16\pi)^{1/3}(9V)^{2/3}$

Question 600:

Express the volume of a cube, *V,* in terms of its surface area, *S*.

A. $V = (S/6)^{3/2}$
B. $V = S^{3/2}$
C. $V = (6/S)^{3/2}$
D. $V = (S/6)^{1/2}$
E. $V = (S/36)^{1/2}$

Question 601:

Solve the equations $4x+3y = 7$ and $2x + 8y = 12$.

A. $(x,y) = \left(\frac{17}{13}, \frac{10}{13}\right)$
B. $(x,y) = \left(\frac{10}{13}, \frac{17}{13}\right)$
C. $(x,y) = (1, 2)$
D. $(x,y) = (2, 1)$
E. $(x,y) = (6, 3)$

Question 602:

Rearrange $\frac{(7x + 10)}{(9x + 5)} = 3y^2 + 2$, to make x the subject.

A. $\frac{15\ y^2}{7 - 9\ (3y^2 + 2)}$

B. $\frac{15\ y^2}{7 + 9\ (3y^2 + 2)}$

C. $-\frac{15\ y^2}{7 - 9\ (3y^2 + 2)}$

D. $-\frac{15\ y^2}{7 + 9\ (3y^2 + 2)}$

E. $-\frac{5\ y^2}{7 + 9\ (3y^2 + 2)}$

Question 603:

Simplify $3x\left(\frac{3x^7}{\frac{1}{x^3}}\right)^3$

A. $9x^{20}$
B. $27x^{20}$
C. $87x^{20}$
D. $9x^{21}$
E. $81x^{21}$

Question 604:

Simplify $2x[(2x)^7]^{\frac{1}{14}}$

A. $2x\sqrt{2x^4}$
B. $2x\sqrt{2x^3}$
C. $2\sqrt{2x^4}$
D. $2\sqrt{2x^3}$
E. $8x^3$

Question 605:
What is the circumference of a circle with an area of 10π?

A. $2\pi\sqrt{10}$
B. $\pi\sqrt{10}$
C. 10π
D. 20π
E. $\sqrt{10}$

Question 606:
If a.b = (ab) + (a + b), then calculate the value of (3.4).5

A. 19
B. 54
C. 100
D. 119
E. 132

Question 607:
If $a.b = \frac{a^b}{a}$, calculate (2.3).2

A. 16/3
B. 1
C. 2
D. 4
E. 8

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Question 608:
Solve $x^2 + 3x - 5 = 0$

A. $x = -\frac{3}{2} \pm \frac{\sqrt{11}}{2}$
B. $x = \frac{3}{2} \pm \frac{\sqrt{11}}{2}$
C. $x = -\frac{3}{2} \pm \frac{\sqrt{11}}{4}$
D. $x = \frac{3}{2} \pm \frac{\sqrt{11}}{4}$
E. $x = -\frac{3}{2} \pm \frac{\sqrt{29}}{2}$

Question 609:
How many times do the curves $y = x^3$ and $y = x^2 + 4x + 14$ intersect?

A. 0
B. 1
C. 2
D. 3
E. 4

Question 610:
Which of the following graphs **do not** intersect?

1. $y = x$
2. $y = x^2$
3. $y = 1-x^2$
4. $y = 2$

A. 1 and 2
B. 2 and 3
C. 3 and 4
D. 1 and 3
E. 1 and 4

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Question 611:
Calculate the product of 897,653 and 0.009764.

A. 87646.8
B. 8764.68
C. 876.468
D. 87.6468
E. 8.76468

Question 612:
Solve for x: $\frac{7x+3}{10} + \frac{3x+1}{7} = 14$

A. $\frac{929}{51}$
B. $\frac{949}{47}$
C. $\frac{949}{79}$
D. $\frac{980}{79}$
E. None of the above

Question 613:
What is the area of an equilateral triangle with side length x?

A. $\frac{x^2\sqrt{3}}{4}$
B. $\frac{x\sqrt{3}}{4}$
C. $\frac{x^2}{2}$
D. $\frac{x\sqrt{3}}{2}$
E. $\frac{x^2}{4}$

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Question 614:

Simplify $3 - \frac{7x\,(25x^2 - 1)}{49x^2\,(5x + 1)}$

A. $3 - \frac{5x - 1}{7x}$

B. $3 - \frac{5x + 1}{7x}$

C. $3 + \frac{5x - 1}{7x}$

D. $3 + \frac{5x + 1}{7x}$

E. $3 - \frac{5x^2}{49}$

Question 615:

Solve the equation $x^2 - 10x - 100 = 0$

A. $-5 \pm 5\sqrt{5}$

B. $-5 \pm \sqrt{5}$

C. $5 \pm 5\sqrt{5}$

D. $5 \pm \sqrt{5}$

E. $5 \pm 5\sqrt{125}$

Question 616:

Rearrange $x^2 - 4x + 7 = y^3 + 2$ to make x the subject.

A. $x = 2 \pm \sqrt{y^3 + 1}$

B. $x = 2 \pm \sqrt{y^3 - 1}$

C. $x = -2 \pm \sqrt{y^3 - 1}$

D. $x = -2 \pm \sqrt{y^3 + 1}$

E. x cannot be made the subject for this equation.

Question 617:

Rearrange $3x + 2 = \sqrt{7x^2 + 2x + y}$ to make y the subject.

A. $y = 4x^2 + 8x + 2$
B. $y = 4x^2 + 8x + 4$
C. $y = 2x^2 + 10x + 2$
D. $y = 2x^2 + 10x + 4$
E. $y = x^2 + 10x + 2$

Question 618:

Rearrange $y^4 - 4y^3 + 6y^2 - 4y + 2 = x^5 + 7$ to make y the subject.

A. $y = 1 + (x^5 + 7)^{1/4}$
B. $y = -1 + (x^5 + 7)^{1/4}$
C. $y = 1 + (x^5 + 6)^{1/4}$
D. $y = -1 + (x^5 + 6)^{1/4}$
E. Not possible.

Question 619:

The aspect ratio of my television screen is 4:3 and the diagonal is 50 inches. What is the area of my television screen?

A. 1,200 inches^2
B. 1,000 inches^2
C. 120 inches^2
D. 100 inches^2
E. More information needed.

Question 620:

Rearrange the equation $\sqrt{1 + 3x^{-2}} = y^5 + 1$ to make x the subject.

A. $x = \sqrt{\frac{y^{10} + 2y^5}{3}}$

B. $x = \frac{3}{(y^{10} + 2y^5)}$

C. $x = \sqrt{\frac{3}{y^{10} + 2y^5}}$

D. $x = \frac{(y^{10} + 2y^5)}{3}$

E. $x = \sqrt{\frac{y^{10} + 2y^5 + 2}{3}}$

Question 621:

Two lines on a graph are given by the equations 3x - 5y = 10 and 2x+2y = 13. Find the point where they intersect.

A. $(x, y) = (\frac{19}{16}, \frac{85}{16})$

B. $(x, y) = (\frac{85}{16}, -\frac{19}{16})$

C. $(x, y) = (\frac{85}{16}, \frac{19}{16})$

D. $(x, y) = (-\frac{85}{16}, -\frac{19}{16})$

E. No solutions possible.

Question 622:

The two inequalities $x + y \leq 3$ and $x^3 - y^2 < 3$ define a region on a plane. Which of the following points is inside the region?

A. (2, 1)
B. (2.5, 1)
C. (1, 2)
D. (3, 5)
E. (1, 2.5)

Question 623:

How many times do $y = x + 4$ and $y = 4x^2 + 5x + 5$ intersect?

A. 0
B. 1
C. 2
D. 3
E. 4

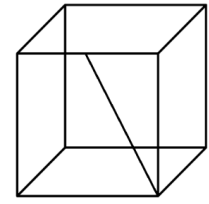
Question 624:

How many times do $y= x^3$ and $y = x$ intersect?

A. 0
B. 1
C. 2
D. 3
E. 4

Question 625:

A cube has unit length sides. What is the length of a line joining a vertex to the midpoint of the opposite side?



A. $\sqrt{2}$
B. $\sqrt{\frac{3}{2}}$
C. $\sqrt{3}$
D. $\sqrt{5}$
E. $\frac{\sqrt{5}}{2}$

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Question 626:

Solve for x, y, and z.

$$x + y - z = -1$$
$$2x - 2y + 3z = 8$$
$$2x - y + 2z = 9$$

Option	x	y	z
A	2	-15	-14
B	15	2	14
C	14	15	-2
D	-2	15	14
E	2	-15	14

Question 627:

Fully factorise: $3a^3 - 30a^2 + 75a$

A. $3a\,(a - 3)^3$
B. $a\,(3a - 5)^2$
C. $3a\,(a^2 - 10a + 25)$
D. $3a\,(a - 5)^2$
E. $3a\,(a + 5)^2$

Question 628:

Solve for x and y:

$$4x + 3y = 48$$
$$3x + 2y = 34$$

Option	x	y
A	8	6
B	6	8
C	3	4
D	4	3
E	30	12

Question 629:

Evaluate: $\frac{-\left(5^2 - 4 \times 7\right)^2}{-6^2 + 2 \times 7}$

A. $-\frac{3}{50}$
B. $\frac{11}{22}$
C. $-\frac{3}{22}$
D. $\frac{9}{50}$
E. $\frac{9}{22}$

Question 630:

All license plates are 6 characters long. The first 3 characters consist of letters and the next 3 characters of numbers. How many unique license plates are possible?

A. 676,000
B. 6,760,000
C. 67,600,000
D. 1,757,600
E. 17,576,000

Question 631:

How many solutions are there for: $2\ (2\ (x^2 - 3x)\ ) = -9$?

A. 0
B. 1
C. 2
D. 3
E. Infinite solutions.

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Question 632:

Evaluate: $\left(x^{\frac{1}{2}}\, y^{-3}\right)^{\frac{1}{2}}$

A. $\frac{x^{\frac{1}{2}}}{y}$

B. $\frac{x}{y^{\frac{3}{2}}}$

C. $\frac{x^{\frac{1}{4}}}{y^{\frac{3}{2}}}$

D. $\frac{y^{\frac{1}{4}}}{x^{\frac{3}{2}}}$

E. No solutions

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Question 633:

Bryan earned a total of £ 1,240 last week from renting out three flats. From this, he had to pay 10% of the rent from the 1-bedroom flat for repairs, 20% of the rent from the 2-bedroom flat for repairs, and 30% from the 3-bedroom flat for repairs. The 3-bedroom flat costs twice as much as the 1-bedroom flat. Given that the total repair bill was £ 276 calculate the rent for each apartment.

Option	1 Bedroom	2 Bedrooms	3 Bedrooms
A	280	400	560
B	140	200	280
C	420	600	840
D	250	300	500
E	500	600	1,000

Question 634:

Evaluate: $5\ [5\ (6^2 - 5 \times 3) + 400^{\frac{1}{2}}]^{1/3} + 7$

A. 0
B. 25
C. 32
D. 49
E. 56

Question 635:

What is the area of a regular hexagon with side length 1?

A. $3\sqrt{3}$
B. $\frac{3\sqrt{3}}{2}$
C. $\sqrt{3}$
D. $\frac{\sqrt{3}}{2}$
E. 6

Question 636:

Dexter moves into a new rectangular room that is 19 metres longer than it is wide, and its total area is 780 square metres. What are the room's dimensions?

A. Width = 20 m; Length = -39 m
B. Width = 20 m; Length = 39 m
C. Width = 39 m; Length = 20 m
D. Width = -39 m; Length = 20 m
E. Width = -20 m; Length = 39 m

Question 637:

Tom uses 34 meters of fencing to enclose his rectangular lot. He measured the diagonals to 13 metres long. What is the length and width of the lot?

A. 3 m by 4 m
B. 5 m by 12 m
C. 6 m by 12 m
D. 8 m by 15 m
E. 9 m by 15 m

Question 638:

Solve $\frac{3x - 5}{2} + \frac{x + 5}{4} = x + 1$

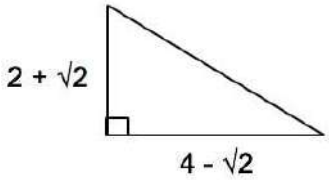
A. 1
B. 1.5
C. 3
D. 3.5
E. 4.5

Question 639:

Calculate: $\frac{5.226 \times 10^6 + 5.226 \times 10^5}{1.742 \times 10^{10}}$

A. 0.033
B. 0.0033
C. 0.00033
D. 0.000033
E. 0.0000033

Question 640:
Calculate the area of the triangle shown to the right:



A. $3 + \sqrt{2}$
B. $\frac{2 + 2\sqrt{2}}{2}$
C. $2 + 5\sqrt{2}$
D. $3 - \sqrt{2}$
E. 3

Question 641:
Rearrange $\sqrt{\frac{4}{x} + 9} = y - 2$ to make x the subject.

A. $x = \frac{11}{(y - 2)^2}$
B. $x = \frac{9}{(y - 2)^2}$
C. $x = \frac{4}{(y + 1)(y - 5)}$
D. $x = \frac{4}{(y - 1)(y + 5)}$
E. $x = \frac{4}{(y + 1)(y + 5)}$

Question 642:
When 5 is subtracted from 5x the result is half the sum of 2 and 6x. What is the value of x?

A. 0
B. 1
C. 2
D. 3
E. 4

Question 643:

Estimate $\frac{54.98 + 2.25^2}{\sqrt{905}}$

A. 0
B. 1
C. 2
D. 3
E. 4

Question 644:

Pain nerve impulses are twice as fast as normal touch impulses. If Yun touches a boiling hot pan this message reaches her brain, 1 metre away, in 1 millisecond. What is the speed of a normal touch impulse?

A. 5 m/s
B. 20 m/s
C. 50 m/s
D. 200m/s
E. 500 m/s

Question 645:

Solve the simultaneous equations $x^2 + y^2 = 1$ and $x + y = \sqrt{2}$, for $x, y > 0$

A. $(x,y) = (\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2})$
B. $(x,y) = (½, \frac{\sqrt{3}}{2})$
C. $(x,y) = (\sqrt{2}-1, 1)$
D. $(x,y) = (\sqrt{2}, ½)$
E. Multiple answers

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Question 646:

Which of the following statements is **FALSE**?

A. Congruent objects always have the same dimensions and shape.
B. Congruent objects can be mirror images of each other.
C. Congruent objects do not always have the same angles.
D. Congruent objects can be rotations of each other.
E. Two triangles are congruent if they have two sides and one angle of the same magnitude.

Question 647:

Solve the inequality $x^2 \geq 6 - x$

A. $x \leq -3$ and $x \leq 2$
B. $x \leq -3$ and $x \geq 2$
C. $x \geq -3$ and $x \leq 2$
D. $x \geq -3$ and $x \geq 2$
E. $x \geq 2$ only

Question 648:

The hypotenuse of an isosceles right-angled triangle is x cm. What is the triangle's area in terms of x?

A. $\frac{\sqrt{x}}{2}$
B. $\frac{x^2}{4}$
C. $\frac{x^2}{2}$
D. $\frac{3x^2}{4}$
E. $\frac{x^2}{10}$

Question 649:

Mr Heard derives a formula: $Q = \frac{(X + Y)^2 A}{3B}$. He doubles the values of X and Y, halves the value of A and triples the value of B. What happens to value of Q?

A. Decreases by $\frac{1}{3}$
B. Increases by $\frac{1}{3}$
C. Decreases by $\frac{2}{3}$
D. Increases by $\frac{2}{3}$
E. Increases by $\frac{4}{3}$

Question 650:

Consider the graphs $y = x^2 - 2x + 3$, and $y = x^2 - 6x - 10$. Which of the following is true?

A. Both equations intersect the x-axis.
B. Neither equation intersects the x-axis.
C. The first equation does not intersect the x-axis; the second equation intersects the x-axis.
D. The first equation intersects the x-axis; the second equation does not intersect the x-axis.
E. Only the second equation intersects the Y axis.

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ANSWERS

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ANSWER KEY

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Q	A	Q	A	Q	A	Q	A
1	A	36	A	71	E	106	C
2	C	37	A	72	B	107	B
3	A	38	B	73	A	108	A
4	E	39	D	74	C	109	C
5	C	40	A	75	D	110	B
6	D	41	B	76	A	111	C
7	E	42	B	77	B	112	D
8	A	43	E	78	D	113	C
9	E	44	B	79	A	114	B
10	B	45	D	80	B	115	B
11	D	46	E	81	E	116	D
12	C	47	B	82	B	117	E
13	D	48	D	83	C	118	D
14	A	49	B	84	C	119	D
15	D	50	E	85	E	120	B
16	A	51	D	86	C	121	B
17	B	52	B	87	C	122	C
18	B	53	D	88	A	123	C
19	A	54	A	89	C	124	D
20	E	55	C	90	C	125	B
21	A	56	D	91	A	126	C
22	C	57	C	92	A	127	B
23	A	58	A	93	D	128	E
24	C	59	D	94	B	129	B
25	B	60	D	95	E	130	D
26	A	61	D	96	E	131	D
27	D	62	E	97	D	132	C
28	A	63	C	98	D	133	C

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29	A	**64**	B	**99**	E	**134**	B
30	B	**65**	B	**100**	A	**135**	C
31	A	**66**	D	**101**	C	**136**	C
32	E	**67**	E	**102**	D	**137**	C
33	B	**68**	C	**103**	C	**138**	D
34	B	**69**	E	**104**	D	**139**	C
35	D	**70**	D	**105**	D	**140**	E

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Q	A	Q	A	Q	A	Q	A
141	D	**176**	A	**211**	B	**246**	E
142	C	**177**	C	**212**	E	**247**	C
143	A	**178**	A	**213**	D	**248**	B
144	A	**179**	B	**214**	C	**249**	E
145	E	**180**	C	**215**	B	**250**	D
146	D	**181**	A	**216**	E	**251**	**C**
147	D	**182**	B	**217**	C	**252**	B
148	B	**183**	E	**218**	C	**253**	C
149	D	**184**	C	**219**	E	**254**	D
150	A	**185**	E	**220**	B	**255**	A
151	B	**186**	B	**221**	D	**256**	D
152	C	**187**	B	**222**	C	**257**	B
153	B	**188**	C	**223**	D	**258**	D
154	C	**189**	C	**224**	E	**259**	D
155	D	**190**	C	**225**	B	**260**	C
156	D	**191**	E	**226**	C	**261**	C
157	C	**192**	C	**227**	C	**262**	C
158	C	**193**	A	**228**	D	**263**	A
159	C	**194**	C	**229**	B	**264**	B
160	A	**195**	A	**230**	E	**265**	E
161	C	**196**	B	**231**	C	**266**	B
162	A	**197**	B	**232**	A	**267**	A
163	E	**198**	E	**233**	C	**268**	D
164	C	**199**	E	**234**	C	**269**	B
165	B	**200**	C	**235**	D	**270**	C
166	B	**201**	B	**236**	A	**271**	B
167	C	**202**	C	**237**	D	**272**	D
168	B	**203**	D	**238**	D	**273**	E

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169	C	**204**	C	**239**	C	**274**	C
170	E	**205**	B	**240**	C	**275**	B
171	D	**206**	D	**241**	C	**276**	A
172	C	**207**	C	**242**	**E**	**277**	B
173	B	**208**	C	**243**	D	**278**	A
174	E	**209**	A	**244**	C	**279**	C
175	D	**210**	C	**245**	D	**280**	C

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Q	A	Q	A	Q	A	Q	Q
281	C	**316**	D	**351**	D	**386**	E
282	C	**317**	A	**352**	A	**387**	D
283	C	**318**	D	**353**	B	**388**	C
284	D	**319**	D	**354**	C	**389**	A
285	C	**320**	B	**355**	C	**390**	D
286	D	**321**	A	**356**	A	**391**	E
287	C	**322**	E	**357**	B	**392**	D
288	C	**323**	D	**358**	C	**393**	C
289	C	**324**	E	**359**	B	**394**	B
290	C	**325**	E	**360**	E	**395**	E
291	E	**326**	E	**361**	E	**396**	A
292	**C**	**327**	D	**362**	E	**397**	B
293	C	**328**	C	**363**	A	**398**	C
294	E	**329**	E	**364**	A	**399**	A
295	C	**330**	E	**365**	A	**400**	A
296	C	**331**	C	**366**	C	**401**	D
297	C	**332**	C	**367**	A	**402**	E
298	C	**333**	A	**368**	A	**403**	A
299	D	**334**	E	**369**	E	**404**	A
300	C	**335**	A	**370**	E	**405**	D
301	A	**336**	A	**371**	D	**406**	C
302	E	**337**	C	**372**	B	**407**	B
303	E	**338**	A	**373**	D	**408**	E
304	A	**339**	E	**374**	A	**409**	A
305	C	**340**	E	**375**	E	**410**	C
306	C	**341**	C	**376**	A	**411**	C
307	D	**342**	E	**377**	D	**412**	E
308	B	**343**	B	**378**	E	**413**	E

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309	A	**344**	E	**379**	A	**414**	E
310	D	**345**	E	**380**	A	**415**	D
311	D	**346**	B	**381**	C	**416**	A
312	A	**347**	A	**382**	B	**417**	C
313	C	**348**	E	**383**	A	**418**	B
314	A	**349**	C	**384**	A	**419**	D
315	E	**350**	B	**385**	C	**420**	B

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Q	A	Q	A	Q	A	Q	A
421	E	**456**	E	**491**	D	**526**	D
422	B	**457**	D	**492**	A	**527**	E
423	D	**458**	D	**493**	B	**528**	E
424	D	**459**	E	**494**	A	**529**	B
425	D	**460**	C	**495**	E	**530**	A
426	D	**461**	A	**496**	E	**531**	C
427	E	**462**	B	**497**	C	**532**	E
428	E	**463**	E	**498**	D	**533**	D
429	B	**464**	C	**499**	A	**534**	D
430	B	**465**	D	**500**	A	**535**	E
431	E	**466**	C	**501**	E	**536**	B
432	A	**467**	C	**502**	A	**537**	A
433	B	**468**	E	**503**	D	**538**	E
434	E	**469**	C	**504**	E	**539**	D
435	B	**470**	B	**505**	E	**540**	E
436	D	**471**	B	**506**	C	**541**	E
437	A	**472**	B	**507**	D	**542**	A
438	A	**473**	E	**508**	E	**543**	B
439	B	**474**	D	**509**	D	**544**	C
440	C	**475**	C	**510**	D	**545**	D
441	B	**476**	E	**511**	E	**546**	E
442	A	**477**	A	**512**	B	**547**	E
443	D	**478**	B	**513**	C	**548**	C
444	A	**479**	C	**514**	E	**549**	C
445	E	**480**	C	**515**	D	**550**	B
446	D	**481**	D	**516**	E	**551**	**D**
447	E	**482**	A	**517**	A	**552**	E
448	C	**483**	C	**518**	E	**553**	E

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449	E	**484**	C	**519**	D	**554**	D
450	D	**485**	E	**520**	E	**555**	D
451	A	**486**	C	**521**	E	**556**	A
452	D	**487**	D	**522**	E	**557**	E
453	D	**488**	A	**523**	E	**558**	C
454	C	**489**	B	**524**	D	**559**	D
455	E	**490**	D	**525**	E	**560**	C

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Q	A	Q	A	Q	A	Q	A
561	D	**584**	E	**607**	D	**630**	E
562	E	**585**	C	**608**	E	**631**	B
563	B	**586**	E	**609**	B	**632**	C
564	A	**587**	E	**610**	C	**633**	A
565	C	**588**	E	**611**	B	**634**	C
566	C	**589**	B	**612**	C	**635**	B
567	E	**590**	C	**613**	A	**636**	B
568	C	**591**	B	**614**	A	**637**	B
569	B	**592**	B	**615**	C	**638**	C
570	B	**593**	C	**616**	B	**639**	C
571	E	**594**	D	**617**	D	**640**	A
572	C	**595**	C	**618**	C	**641**	C
573	E	**596**	B	**619**	A	**642**	D
574	E	**597**	A	**620**	C	**643**	C
575	D	**598**	E	**621**	C	**644**	E
576	B	**599**	D	**622**	C	**645**	A
577	C	**600**	A	**623**	B	**646**	C
578	C	**601**	B	**624**	D	**647**	B
579	C	**602**	A	**625**	E	**648**	B
580	E	**603**	E	**626**	D	**649**	A
581	A	**604**	D	**627**	D	**650**	C
582	C	**560**	A	**628**	B		
583	E	**606**	D	**629**	E		

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WORKED ANSWERS

Question 1: A

Whilst **B**, **C** and **D** may be true, they are not clearly stated in the text. **E is an argument in favour of A. A** is clearly stated and so is the correct answer.

Question 2: C

The main argument of the first paragraph is to propose the point that it is society that controls gender behavior, not genetics. **A** and **E** are not correct either as they only allude to the end result of gender behaviour and so are incorrect. Hormonal effects are not mentioned in the first paragraph and so **B** is incorrect. Although **D** is relevant, it is still possible that hormonal and environmental impacts are important, even if socialisation is more significant. **C** would undermine the argument that society predominately controls gender, and so is correct.

Question 3: A

B, **C** and **D** are not stated and so are incorrect. **E** is alluded to by the text, but it does not explain how culture actually affects identity, only that it does. **A** is directly stated and so is correct.

Question 4: E

A is relevant and could be true, but nothing about fluidity is mentioned. **B** and **D** are contraindicated by the statement and so are incorrect. **C** could be true but implies children always like the same thing as their same-gendered parent irrelevant of how they are treated as a child, which is contrary to the statement and so is not correct. **E** is correct as it is the overall message.

Question 5: C

D may help prevent problems with sexual identity but does not prevent stereotyping and so is incorrect. **A** is not stated, and **B** is implied but not stated, and so **A** and **B** are incorrect. **E** is too specific – the emphasis is more on children having choice. **C** is the end message of how to prevent gender stereotyping and so is correct.

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Question 6: D

A, **B** and **C** may be true but are not mentioned in the statement and so are incorrect. **E** goes too far in saying they may have a specific kind of problem. The statement implies that children born with different external organs to those that their sex chromosomes would match may find it difficult to accept this difference and be uncomfortable. However, the statement does ask "how then are they ever to feel comfortable in their own skin?", when talking about children whose external sex organs do not match their sex chromosomes, suggesting that **D** is the correct answer.

Question 7: E

The text states that 'Those who regularly took 30-minute naps were more than twice as likely to remember simple words such as those of new toys.' Which means those who napped were more than twice as likely to remember teddy's name than the 5% who did not.

5% x 2 = 10%

10% of 100 is 10

So if the toddlers that napped were more than twice as likely to remember the teddy's name, then more than 10 of them would be expected to remember. The only option that is greater than 10 is E, which is the answer.

Question 8: A

B is incorrect as, though toddlers who nap are more likely to remember the names of new objects, saying all toddlers who nap have better memories is too strong a statement. C is weakly suggested by the statement as it is suggested toddlers who nap are less irritable, but they are also more likely to have night-time sleep disturbances and the statement only spoke about the benefits of a routine, not napping specifically. D is wrong as the statement does not refer to improved memory as an adult and only calls the research 'potential links'. E is also wrong as regular does not necessarily mean every day, and the passage does not mention if you should force a toddler to nap if they do not want to. A is the correct answer, as the passage does suggest many times that regular napping and a routine is beneficial for toddlers.

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Question 9: E

A, B, C and D may be true but there is nothing in the text to support them. However, the passage states, "non-napping counterparts, who also had higher incidences of memory impairment, behavioural problems and learning difficulties". If the impaired memory were the cause, as opposed to the result, of irregular sleeping then it would offer an alternative reason why those who nap less remember less, so E is the answer.

Question 10: B

A and C are possible implications but not stated and so are incorrect. There is no actual evidence that E is comparatively more important than any other factor. It said that parents cite napping having 'the benefits of their child having a regular routine' so B is more correct than D as it refers to the benefit to the toddlers' rather than the parents.

Question 11: D

B, if true would counteract the conclusion, as it would imply that the study is skewed. The same is true of C, which if true, would imply unreliable results as the toddler sample are all the same age within a year, but not within a few weeks. A, if true, would not provide any additional support to the conclusion and so is incorrect. E does not necessarily link to memory, as there would be far too many other variables. D if true would provide the most support for the conclusion as it proposes using groups with a higher incidence of napping in comparison to those with a lower incidence.

Question 12: C

Although it can be argued that **A**, **B**, **D** and **E** are true they are not the best answer to demonstrate a flaw in Tom's father's argument. **C** is the best because it accounts for other factors determining success for the Geography A-level exam such as aptitude for the subject or issues on exam day.

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Question 13: D

A is never stated and is incorrect. **B** and **C** are referred to being 'many people's' beliefs and are cited as others' opinions, not an argument supported by evidence in the passage, and so are not valid conclusions. **E** is incorrect as the statement is that fertility treatments are less important than nurses and doctors. It is implied that the NHS may have to reduce its services in the future, some of which could be fertility treatments, so **D** is the most correct answer.

Question 14: A

C does not really affect the strength of the argument, as it is only relevant to the length of the time taken for the effects of the argument to come into place. **D** is incorrect, as people breaking speed limits already would not negate the argument that speed limits should be removed but could even be seen as supporting it. These people may count as the 'dangerous drivers' who would be ultimately weeded out of the population. **E** is not really relevant, because if it is excessively dangerous the driver may still die, and secondly the argument is to allow people to drive faster.

B may affect part of the argument's logic (as it undermines the idea that dangerous drivers are born to dangerous drivers), but the final conclusion that dangerous drivers will end up killing only themselves still stands, and so the ultimate population of only safe drivers may be obtained. The fact that one dead dangerous driver could have produced a safe one does not necessarily challenge the main point of this argument. **A**, if true, would most weaken the argument as it states that fast driver is more likely to harm others and not the driver itself, which would negate the whole argument.

Question 15: D

Whilst is it stated that the Government assesses risk, it is not described as an obligation, hence **A** is incorrect. The overall conclusion of the statement is that on balance the Government was justified in not spending money on flooding preparation, as it was unlikely to occur, so **C**, **B** and **E** are incorrect, and **D** is correct

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Question 16: A

C is incorrect and **D** is a possible course of action rather than a conclusion. **B** and **E** are possible inferences but not the conclusion of the statement. The overall conclusion of the statement is that the way that children interact has changed to the solitary act of playing computer games.

Question 17: B

The passage does state that in this case the £473 million could have been put to better use, however, there is no mention that no drug should ever be stockpiled for a similar possible pandemic. The passage discusses the lack of evidence behind Tamiflu and therefore is stating that in a situation where there is a lack of evidence, there may not be justification for stockpiling millions of pounds worth of the drug. Stockpiling in the case of drugs with high effectiveness is not discussed so we should not assume this is a generic argument against preparation for any pandemic and stockpiling of any drug. The passage does not say we should never use them, only that stockpiling might not be sensible. Consequently, **B** is the correct answer as it best summarises the author's view.

Question 18: B

The passage discusses the fact that unhealthy eating is associated with other aspects of an unhealthy lifestyle so the argument that tackling only the unhealthy eating aspect does not logically follow. The other statements are all possible reasons why the solution given may not be optimal but are not directly referred to in the passage.

Question 19: A

This is a tricky question in which **A**, **B**, **C** and **D** are all true. However, the question asks for the conclusion of the passage, which is best represented by **A**. **B** is a premise that gives justification for why the elderly should take care of themselves and **C** provides a justification for why they may not. **D** is implied in the text, but statement **A** is explicitly stated and so is correct. **E** is incorrect as the passage implies that people should spend the money that they have in old age, not stop saving altogether.

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Question 20: E

The passage states stem cell research is an area where there are possible high financial and personal gains. However, there is no mention of these being the main driving factors in either this area of research or others. Although rivalry between groups may be a reason driving publishing, this is not mentioned in the passage. The image discrepancies were in only one paper, but the passage implies the protocol and replication problems were in both papers.

Question 21: A

D actually weakens the argument and is therefore not a conclusion. **C** is simply a fact stated to introduce the argument and is not a conclusion. **E** is not discussed in the passage. **B** is a reason given in the passage to support the main conclusion. If we accept **B** as being true, it helps support the statement in **A**, which is the main conclusion.

Question 22: C

The passage describes improved safety features and better brakes in cars and concludes that this means the road limit could be increased to 80mph without causing more road fatalities. However, if **C** is not true, this conclusion no longer follows on from this reasoning. At no point is it stated that **C** is true, so **C** is therefore the assumption in the passage. The statements in **B** and **D** are not *required* to be true for the argument's conclusion to lead on from its reasoning. **A** is a statement which is strengthened by this passage and is not an assumption from the passage. **E** is not relevant to the conclusion or mentioned in the passage.

Question 23: A

Answers **C**, **D** and **E** obviously present ways in which the conclusions drawn from the study could be wrong, without any mistakes being made by those carrying out the study, and thus are potential reasons. B is also a potential reason, because those with a low alcohol consumption could have many other risk factors for cancer and end up with a higher overall risk. If the study does not take account of these, it could produce erroneous conclusions. A cannot be a valid reason because the passage states that it is proven that alcohol increases the risk of cancer. Thus, we must accept this as true, so **A** is not a potential reason.

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Question 24: C

Answers **A** and **D** are both reasons given to explain fingerprints under the theory of evolution, and contribute towards the notion given in **C**, that they do not offer support to intelligent design. Thus, **A** and **D** are reasons given in the passage, and **C** is the main conclusion so is the answer. **B** is simply a fact stated to introduce the passage, whilst **E** actually contradicts something mentioned in the argument (namely that Intelligent Design is religious-based, and scientifically discredited). Neither of these options are conclusions.

Question 25: B

The passage states that the average speed *including* time spent stood still at stations was 115mph. Thus, **A** is incorrect, as the stopping points have already been included in the calculations of journey time. Similarly, the passage states that the train completes its journey at Kings Cross, so **D** is incorrect. **C** is not correct because we have been given the total length of the journey. Whether it took the most direct route is irrelevant. **E** is completely irrelevant and does not affect the answer. **B** is an assumption, because we have only been given the *scheduled* time of departure. If the train was delayed in leaving, it would not have left at 3:30, and so would have arrived *after* 5:30.

Question 26: A

The argument discusses healthcare spending in England and Scotland, and whether this means the population in Scotland will be healthier. It says nothing about whether this system is fair and does not mention the expenditure in Wales. Thus, **C** and **D** are incorrect. Similarly, the argument makes no reference to whether healthcare spending should be increased, so **B** is incorrect. **E** is true but not the main message of the passage. The passage does suggest that the higher healthcare expenditure per person in Scotland does not necessarily mean that the Scottish population will be healthier, so **A** is a conclusion from this passage.

Question 27: D

C is an incorrect statement, as the passage says that Polio *hasn't* been eradicated yet. **A** and **B** are reasons given to support the conclusion, which is that given in **D**. **E**, meanwhile, is an opinion given in the passage, and is not relevant to the passage's conclusion.

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Question 28: A

This passage provides various positive points of the Y chromosome, before describing how all of this means it is a fantastic tool for genetic analysis. Thus, the conclusion is clearly that given in **A**. The statement in **B** is a further point given to provide evidence of its utility, as stated in the passage. Thus, **B** is not a conclusion in itself, but further evidence to support the main conclusion, given in **A**. **C** is also a reason given to support the conclusion in **A**, whilst **D** is simply a fact stated to introduce the passage. As for **E,** there is no mention of Genghis Khan's children (only his descendants).

Question 29: A

Answers **C** and **E** are not valid assumptions because the argument has stated that a patient must be treated with antibiotics for a bacterial infection to clear. **B** is not a flaw, because this does not affect whether the antibiotics would clear the infection if it were bacterial. **D** is an irrelevant statement, and also disagrees with a phrase in the passage (that antibiotics are required to clear a bacterial infection). **A** is a valid flaw, because the passage does not say that antibiotics are sufficient or guaranteed to clear a bacterial infection, simply that they are necessary. Thus, it is possible that the infection is bacterial, but the antibiotics failed to clear it.

Question 30: **B**

A, **C** and **D**, if accepted as true, all contribute towards supporting the statement given in **B**, which is a valid conclusion given in this passage. Thus, **A**, **C** and **D** are all reasons given to support the main conclusion, which is the statement given in **B**. **E** is not a valid conclusion, as the passage makes no reference to action that should be taken relating to smoking, it simply discusses its position as the main risk factor for lung cancer.

Question 31: A

D is only given as a method, with no mention of its effectiveness. We do not know if **C** is true because it is not stated. **B** is not discussed in the passage. Whilst statement **E** is true, it is supporting evidence for the conclusion, not the conclusion itself. As a result, we know **A** is the correct answer, as the passage clearly suggests outreach schemes encourage people to apply to university.

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Question 32: E

Whilst **A** and **B** may be true, cost is not mentioned as a deterring factor and we are only concerned with use in the UK, so they are irrelevant. Whether cannabis was the only class C drug is not important to the argument, so **D** is not correct. **E** is the correct answer because the statement concerns the use of cannabis in the UK, directly stating use will decrease from people fearing longer prison sentences from higher-class drugs.

Question 33: B

Whilst **A** and **C** may be true, they are not part of the argument. **D** is possible but cannot be logically proposed from the information above. **E** would be a flaw if the argument were 'all levels of sports teams reduce bullying' but the passage explicitly states 'well-performing' teams. Hence **B** is correct as it undermines the whole argument, reversing the cause and effect.

Question 34: B

Options A, C and D do not directly weaken the argument as if any 16-year-olds were buying/drinking alcohol (whether the minority or majority), police would still be spending time catching them. E does not refute the argument about police time. The suggested benefit to reduce police time spent catching underage drinkers would be negated if B were true, hence it is the correct answer.

Question 35: D

A is an interpretation of the last sentence and doesn't accurately summarise the argument in the passage. **B** is untrue as there is no mention of if the government can afford to give grants or not. **C** and **E** are incorrect as the passage only talks about small businesses. **D** is correct as it best summarises the change in government policy regarding small businesses.

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Question 36: A

The statement discusses a case that was reported but aims to argue that there may be important errors occurring everyday in medicine that go unreported. Option **A** if true, would significantly weaken this argument as would negate it being a possibility. **B, C, D** and **E** may be true, but they do not negate the argument – if doctors are trained, accidents like the above may still occur. Operations that are successful do not affect those that are not, nor do unavoidable errors have any relation to avoidable ones. That the patient may have died without these errors similarly does not mean that errors, when they do occur, should not be considered errors.

Question 37: A

The main point of the statement is to highlight that although there are numerous safety precautions in place to protect patients, when the weaknesses in these precautions align big errors can occur. So, **A** is correct. While **E**, **C, B** and **D** may well be true, they are not the overall conclusion of the statement.

Question 38: B

Though not the first to be cited, the original error is cited as being the incorrect copying of which kidney is to be removed, hence **B** is the correct option. The other options represent errors that in the 'Swiss cheese model' would have not been allowed to occur if the original had not taken place.

Question 39: D

In this instance the 'tip of the iceberg' refers to the number of medical errors reported, implying there may be a significantly larger proportion that go unreported; hence the correct option is **D**, and not **B.**

Question 40: A

The description given about the consultant's performance versus emotional arousal, is described as initially increasing then eventually decreasing over time, which is best represented by graph **A.**

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Question 41: B

The consultant says that the 'public perception is that medical knowledge increases steadily over time' which is best represented by graph **B.** The consultant says the regarding the acquisition of medical knowledge, 'many doctors [reach] their peak in the middle of their careers', which is best described by the graph **D.**

Question 42: B

Obesity is not mentioned in the passage, so **E** is incorrect. There is no mention of exercise specifically as it relates to old age, so **A** and **D** are also wrong. The diseases associated with lack of exercise are not specifically stated to cause early death, only that they are associated with older people, so **C** is also incorrect. The passage does, however, argue that lack of exercise is associated with illness, and so exercise would be linked to a lack of illness, or good health, so **B** is correct.

Question 43: E

The preference of women to have their babies at hospital versus home is not commented upon so **B** is incorrect. **A** and **D** are possible inferences at certain points but not conclusions of the statement. **C** is never implied, only that normal home births are no riskier than those in hospital. The overall conclusion of the statement is that the home births are cheaper than hospital births, and so a rise in the number of women giving birth at home could make NHS maternity care more sustainable. Consequently, **E** is the correct answer.

Question 44: B

While **A, C** and **D** would, if true, make the practicalities of increasing home births more difficult they would not weaken the argument as **B** would**. E is not correct as the core argument is not actually about medicalisation.** Where the statement's whole argument rests on home births being as safe as hospital **B**, if true, would negate this.

Question 45: D

The statement says, 'With the increase in availability of health resources we now, too often, use services such as a full medical team for a process that women have been completing single-handedly for thousands of years.' Thus, implying **D**, 'excessive availability of health resources' is the cause of 'medicalisation of childbirth'.

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Question 46: E

1 and **3** identify weaknesses in the argument. If campaigns are what help keep deaths by fire low, they can be seen as 'necessary', and their necessity may be proven by the promisingly low fire-related mortalities. If there are more people with hernias than in fires, more people can possibly die from hernias, but this does not mean the fires are less dangerous to the (fewer) individuals involved in them. **2** is irrelevant, as the argument is about how dangerous fires are in their entirety, not in relation to their constituent parts. Therefore **E**, '1 and 3 only', is correct.

Question 47: B

Since 'some footballers' that like Maths are not necessarily the same 'some' who like History we can exclude **A** and **D**. Equally, while **C** may or may not be true, we are not given any information about rugby players' preference for History, so it is incorrect. We know that all basketball players like English and Chemistry, and that none of them like History, but as we do not know about a third subject, they may like **E** is incorrect. We know all of the rugby players like English and Geography and some of them Chemistry, hence there must be a section of rugby players that like all three subjects, so **B** is correct.

Question 48: D

The passage discusses the problems surrounding controlling drugs and focuses on the rapid manufacture of new 'legal highs': it is therefore implied that this is the current major problem, so **2** is correct. The passage also suggests that as the authorities cannot keep up with drugs manufacture, the legality of drugs doesn't reflect their risks, so **4** is correct.

1 is incorrect as the passage says health professionals feel legality is less relevant now, but it doesn't say that it is not still important. **3** is incorrect as the last sentence says a potential problem of legal highs is that the risks are not as clear, which contradicts the statement that the public are not concerned about any risks.

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Question 49: B

The passage is discussing how banning those with the mentioned medical conditions from mountain climbing are essential to ensuring safety. It does not claim that this is sufficient to ensure safety, simply that it is necessary. Thus, **C** is irrelevant, as risks from other activities do not affect the risk from mountain climbing. **D** is also irrelevant, because the argument discusses how it is essential to ensure safety of people on WilderTravel holidays, so those using other companies are irrelevant. **A** is an irrelevant statement because the passage is discussing what should be done to ensure safety, not whether this is the morally correct course of action. Thus, a discussion of whether people should choose to accept the risks is not relevant. **E is not a reasoning flaw, but a suggestion of a change that they could make** However, **B** is a flaw, because the guidelines only mention those with severe allergies, so thinking those with less severe allergies are in danger is a false assumption that has been made by the directors.

Question 50: E

The core argument of this passage is that ambulances are underprepared to deal with winter driving conditions and that this is in turn causes delays to patients receiving treatment. Therefore, the most appropriate answer is **E**.

Question 51: D

The hospital director's comments make it abundantly clear that the most important aspect of the new candidate is good surgery skills, because the hospital's surgery success record requires improvement. If we accept his reasoning as being true, then it is clear that the candidate who is most proficient at surgery should be hired, and patient interaction should not be the deciding factor. **E is feasible but given the comments it is reasonable to choose a candidate who is more surgically qualified.** Thus, Candidate 3 should be hired, as suggested by **D**.

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Question 52: B

The passage discusses how anti-vaccine campaigns cause deaths by spreading misinformation and reducing vaccination rates. It claims that in order to protect people, we should block the campaigners from spreading such misinformation freely. Thus it is made clear that this action should be taken because the campaigners cause deaths, not simply because they are spreading misinformation. Thus, **B** is the principle embodied in the passage, and **C** is incorrect. **A** actually demonstrates an opposite principle whilst **D** is a somewhat irrelevant statement, as the passage makes no reference to whether we should promote successful public health programmes. **E** could be correct, but it is not necessarily a direct cause, and is therefore not the answer.

Question 53: D

The passage states that the tumour has established its own blood supply (it says this was shown during the testing), and that a blood supply is necessary for the tumour to grow beyond a few centimetres. Thus **A** and **B** are not assumptions. **C** is not an assumption, as it actually disagrees with something the passage has implied. The passage said that action must be taken, implying that something can be done to stop the tumour. However, at no point has it been said that a blood supply is sufficient for a tumour to grow larger than a few centimetres. If this is not true, then the argument's conclusion that we should expect the tumour to grow larger than a few centimetres, and that action must be taken, no longer readily follows on from its reasoning. It is possible the tumour will still fail to grow larger than a few centimetres. **E** is not a reasoning flaw, just a slight over-interpretation of the facts. Thus, **D** is an assumption in the passage, and a flaw in its reasoning.

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Question 54: A

D is incorrect, as the passage has stated the runners are people running to raise money for the GNAA. **B** and **C**, meanwhile, are incorrect as the passage is only talking about whether the GNAA will be able to get a new helicopter. Thus, references to whether it wishes to, or whether this is the best use of money, are irrelevant. **E** is not mentioned at all so cannot be inferred from the passage. **A**, however, is an assumption on the part of the passage's writer. The passage says that the GNAA will be able to get a helicopter if £500,000 is raised, but this does not mean that it won't be able to if the £500,000 is not raised by the runners. It could well be that they secure funding from elsewhere, or that prices drop. The money being sufficient to get a new helicopter does not mean it is necessary to get one.

Question 55: C

B and D somewhat strengthen this argument, suggesting that more people going on courses leads to better growth, and that people who have gone on these courses are more attractive to employers. A does not really affect the strength of the argument, as the current rate of growth does not affect whether government subsidies would lead to increased growth. E is a suggestion of an alternative, rather than an actual flaw in the reasoning of the argument. C, however, weakens the argument significantly by suggesting that people would not be more likely to attend the courses if the government were to subsidise them, as the cost has little effect on the numbers of people attending.

Question 56: D

B is simply a fact stated in the passage. It doesn't draw upon any other reasons given in the passage, so it is not a conclusion. C is not a conclusion because it does not follow on from the passage's reasoning. The passage discusses what should be done if Pluto is to be classified as a planet, it doesn't say whether this should happen. A and D are both valid conclusions from the passage. However, on closer examination we can see that if we accept A as being true, it gives us good reason to believe the statement in D. Thus, D is the main conclusion in the passage, whilst A is an intermediate conclusion, which goes on to support this main conclusion. E is an assumption that some of the reasoning in the text is based upon.

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Question 57: C

A, B and D would all affect whether the calculation of the Glasgow train's arrival time is correct, but none are assumptions because all of these things have been stated in the passage. E is incorrect as there is no inference of what distance they are talking about (it could be the direct distance, the trainline distance). However, the passage has not stated that the trains will travel at the same speed, and if this is not true, then the conclusion that the Glasgow train will arrive at 8:30pm is no longer valid. Thus, C is an assumption.

Question 58: A

C can actually be seen to be probably untrue, as the passage mentions a need to escape immune responses, suggesting that the immune system can tackle these cells. **E** is true but not representative of the main argument made in the passage. **B** and **D** are not definitely true. The passage mentions several essential steps that must occur, but this does not mean that they are sufficient for carcinogenesis to occur or guaranteed to allow it. Equally, the passage makes no reference to multiple mechanisms by which carcinogenesis can occur. It could be there is only one pattern in which these steps can occur. **A**, however, can be reliably concluded, because the passage does mention several steps that are essential for carcinogenesis to occur.

Question 59: D

Answers **A** and **C** are stated in the passage (the passage states 'deservedly known'), so these can be reliably concluded. **B** can also be concluded, as it is stated that in over 50% of cancers, a loss of functional P53 is identified. **D,** however, cannot be concluded, as the passage simply states that any cell that has a mutation in P53 is at risk of developing dangerous mutations. Thus, it cannot be concluded that a given cell will develop such a mutation.

Question 60: D

D is not an assumption because Sam's calculations are based on the cost per 1000 miles, not on a given amount of fuel being used up. Thus, he has not assumed anything about whether the fuel usage is the same for each car. All of the others are assumptions, which have not been considered. Each of these will affect the total saving he will make if they are not true. For example, if the diesel car costs £100 more than the petrol car, the total saving will be £1700, not £1800 as calculated.

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Question 61: D

The passage discusses how alcohol is more dangerous than cannabis, and states that this highlights the gross inconsistencies in UK drugs policy. Thus, **D** is the main conclusion of the passage, whilst **A** is a reason given to support this conclusion. The passage simply highlights that the policy is grossly inconsistent, and does not mention whether it should be changed, or how (whether alcohol should be banned, or cannabis allowed). Thus, **B** and **C** are not valid conclusions from this passage. The fact that alcohol is freely advertised is only mentioned briefly in the passage to add strength to the argument that alcohol is more accessible than cannabis, but no judgment is made on whether this should not be so, so **E** is also not a valid conclusion from this passage.

Question 62: E

The passage discusses how if first aid supplies were available, many accidents could be avoided. **E** correctly points out that this is a flaw – first aid supplies may help treat accidents and reduce the prevalence of injuries and deaths, but there is no reason why first aid supplies should reduce the incidence of accidents. **B** is a flaw, but not as relevant as **E** because the ability of someone to properly use first-aid supplies would not reduce the probability of an accident occurring. Answers **C** and **D** are irrelevant, since the argument is talking about how first aid supplies could reduce accidents, not injuries or deaths. Thus, discussing cases in which they could not treat the injuries, or whether they need other components to do so is irrelevant. Equally **A** is irrelevant, as the argument is simply talking about what could happen if first aid supplies were stocked in homes and makes no reference to whether this is financially viable.

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Question 63: C

Answers **A** and **D** are not flaws because the passage does not conclude the ideas mentioned in these statements. No mention is made about the safety of the drug, and the argument only states that it is thought the compound may be of use in combating cancer. No premature conclusions are drawn, only suggestions are made. **B** is not a flaw because we can see that the experiments may produce misleading results if the wrong solutions are used, suggesting that DNA replication is inhibited even if it is not. **E is not a reasoning flaw, although more information about the experiments would be better before drawing a conclusion. C**, however, is a valid flaw because the argument erroneously concludes that the wrong solutions must have been used when it says the experiments do not reflect what is actually happening. This clearly indicates a conviction that the wrong solutions were used, which does not follow on from the experiments being old.

Question 64: B

The passage has not said anything about who scored the winning goal, so **A** is not an assumption. **C** is also incorrect, because the passage states that South Shields won the game. **E is incorrect because it is too sweeping – they may not have beaten everyone else. B** correctly identifies that whilst beating South Shields was sufficient to win the league, it was not necessary. If Rotherham wins their other 2 games, they will still win the league, so **B** demonstrates an assumption in the passage. **D** is not relevant, as it does not affect the erroneous nature of the claim that Rotherham will not win the league having lost the match to South Shields.

Question 65: B

C and **D** actually strengthen or reinforce the CEO's reasoning, with **C** suggesting as time progresses Middlesbrough will have more and more people compared to Warrington, whilst **D** suggests that the market share in Warrington may not be as high as suggested, adding further reasons to build in Middlesbrough. **A** somewhat weakens the CEO's argument, but it is not a flaw in the reasoning, because the CEO is simply talking about how Middlesbrough will bring them within the range of more people, so the market share comment is a counterargument, not a flaw in his reasoning. **B**, however, is a valid flaw in this argument. Just because Warrington's population is falling, and Middlesbrough's is rising, does not necessarily mean that Middlesbrough's will be higher.

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Question 66: D

1 and **2** are assumptions. The information given does not necessarily lead on to the conclusion that these extinction events will continue without further conservation efforts. Equally, there is nothing in the passage that says conservation efforts cannot be stepped up without increased funding. However, **3** is not an assumption, because the passage states that global warming has caused changed weather patterns, which have caused destruction of many habitats, which have led to many extinction events. Thus, it is given that global warming has indirectly caused these extinctions, and so the answer is **D**.

Question 67: E

The argument is suggesting that in Austria, the rail service's high passenger numbers and approval ratings are accounted for by the fact that road travel is difficult in much of Austria. It then concludes that the public subsidies have no effect. We can see that **1** instantly weakens this argument by providing evidence to the contrary, as in France, difficult road travel is not prevalent and so cannot account for the high passenger numbers/approval ratings the country possesses. **3** also weakens this conclusion by suggesting multiple factors affect the situation. This makes the conclusion based on the evidence from Austria less strong. Thus, the answer is **E**. **2** actually strengthens the argument that the public subsidies do not cause high passenger numbers/approval ratings, as Italy has high subsidies but low passenger numbers/approval ratings.

Question 68: C

A is incorrect; in 2011 24% of men and 26% of women were obese (one should not confuse this with the rates of combined obese and overweight). **B** is also incorrect, as though what it states is true for adults, the figures for children aged 2-15 have changed little over the past year. **E is wrong as there is no mention of population size. D** is not stated or implied by the passage. **C** is implied in the last two sentences of the article, and so the correct answer.

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Question 69: E

None of these statements can be concluded from the information based on the passage, so **E** is the answer. Though the passage states that smoking causes disease, and you may well know that there is an increased risk of developing lung cancer, liver disease or oral cancer in patients who smoke, no specifics are mentioned so **A**, **B** and **C** cannot be concluded. There is also no information about the drinking habits of smokers, so **D** is also wrong.

Question 70: D

Be careful of using your own knowledge here! Whilst **A** and **B** may be true, they are not the main message of the passage. **C** may be true but is not discussed in the passage. **E** is speculative, as the passage does not say if the transplant would be a 'good alternative'. **D** is correct as it echoes the main message of the passage.

Question 71: E

Smoking and diabetes are risk factors for vascular disease (not a cause), so **A** and **B** are wrong. **C** is also incorrect as vascular disease does not always lead to infarction – the passage only states that it can cause infarction. **D** cannot be concluded as the passage states "necrotic tissue is usually removed in surgery', not that surgery is the only treatment option.

Question 72: B

A is irrelevant to the argument's conclusion. Meanwhile, **E** does nothing to alter the conclusion, as the fact that schools receive similar funds does not affect the fact that more funding could provide better resources, and thus improve educational attainment. **C** actually weakens the argument by implying that banning the richer from using the state school system would not raise many funds, as most do not use it anyway. **D** does not strengthen the conclusion as stating that a gap exists does not do anything to suggest that more funding will help close it. **B** clearly supports the conclusion that more funding, and better resources, would help close the gap in educational attainment.

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Question 73: A

D and **E** are irrelevant to the argument's conclusion. **C** is actually contradicting the argument. **B** is stated in the passage, so is not an assumption of the passage. **A** describes an assumption: the increase of DVDs does not, necessarily, cause the loss of cinema customers.

Question 74: C

The question refers to aeroplanes being the fastest form of transport, and states that this means that travelling by air will allow John to arrive as soon as possible. **C** correctly points out that the argument has neglected to take into account other delays induced by travelling by aeroplane. Cost and legality are irrelevant to the question, so **B** and **E** are incorrect. Meanwhile, **D** actually reinforces the argument, and **A** refers to future possible developments that will not affect John's current journey.

Question 75: D

The argument states that people should not seek to prevent spiders from entering their homes. It does not say anything about whether people should like spiders being in their home, so **A** is incorrect. The argument also makes no allusion to the notion of people preventing flies from entering their homes, so **B** is incorrect. The argument also does not mention or implies that any efforts should be made to encourage spiders to enter homes, or that they should be cultivated, so **C** and **E** are also incorrect.

Question 76: A

A correctly identifies an assumption in the argument. At no point is it stated that bacterial infections in hospitals are resulting in deaths. **B**, **C**, **D** and **E** are all valid points, but they do not affect the notion that pressure for more antibiotic research would save lives. Therefore, none of these statements affect the conclusion of the argument and as such they are not assumptions in this context.

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Question 77: B

The passage does not state that John disregards arguments because of the gender of the speaker, so **D** is incorrect. **A** and **C** are also wrong, as John states he finds women with armpit hair unattractive, so a different face or the knowledge of concealed hair would not make him find the woman in question more appealing to his aesthetic. John does not state Katherine wants other women to stop shaving, so **E** is incorrect. **B** is the correct answer, as Katherine was simply speaking about societal norms, and at no point is it said she was trying to convince John to find her attractive.

Question 78: D

A is irrelevant to the argument, which says nothing about what will happen to medicine in the future. The argument is describing how Sunita is incorrect, how better medicine is not responsible for a high death rate from infectious disease in third world countries, and how better medicine will actually decrease this rate. **C** is a direct contradiction to this conclusion, so is incorrect. **E** is a fact stated in the argument to explain some of its reasoning, and is not a conclusion, therefore **E** is incorrect.

Both **B** and **D** are valid conclusions from the argument. However, **B** is not the main conclusion, because the fact that 'Better medicine is not responsible for a high death rate from infectious disease in third world countries' actually supports the statement in **D**, 'Better medicine will lead to a decrease in the death rate from infectious disease in third world countries'. Therefore, **B** is an example of an intermediate conclusion in this argument, which contributes to supporting the main conclusion, which is that given in **D**.

Question 79: A

The statement in **A**, that housing prices will be higher if demand for housing is higher, is not stated in this argument. However, it is implied to be true, and if it is not true, then the argument's conclusion is not valid from the reasoning given. Therefore, **A** correctly identifies an assumption in the argument. The other statements do not affect how the reasons given in the argument lead to the conclusion of the argument and are therefore not assumptions in the argument.

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Question 80: B

A and **E** are both contradictory to the argument, which concludes that because of the new research, Jellicoe motors should hire a candidate with good team-working skills. **C** refers to an irrelevant scenario, as the argument is referring to only one candidate being hired, and at no point does it state or imply that several should be hired. **B** correctly identifies the conclusion of the argument: that Jellicoe motors should hire a new candidate with good team-working skills in order to boost their productivity and profits. **D** meanwhile exaggerates the consequences of not following this course of action. The argument does not make any reference to the notion that Jellicoe motors will struggle to be profitable if they do not hire a candidate with good team-working skills.

Question 81: E

D is in direct contradiction to the argument, so is not the main conclusion. Meanwhile, **B** is a reason stated in the argument to explain some of the situations described. It is not a conclusion, as it does not follow on from the reasons given in the argument. **A** and **E** are both valid conclusions from the argument. However, only **E** is the main conclusion. This is because both **A** goes on to support the statement in **E**. If bacterial resistance to current antibiotics could result in thousands of deaths, this supports the notion that the UK government must provide incentives for pharmaceutical firms to research new antibiotics if it does not wish to risk thousands of deaths. Meanwhile, **C** appears to be another intermediate conclusion in the argument that also supports the main conclusion. However, on close inspection this is not the case. **C** refers to the UK government directly investing in new antibiotic research, whilst the argument refers to the government providing incentives for pharmaceutical firms to do so. Therefore, **C** is not a valid conclusion from the argument.

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Question 82: B

E is completely irrelevant because the question is referring to an unsustainable solution if the UN's development targets are met, so the likelihood of them being met is irrelevant. **C** is irrelevant because they do not affect the fact that the situation would be unsustainable if everybody used the amount of water used by those in developed countries, as stated in the question. **A** is also irrelevant, as the passage does not mention price as a factor to be considered within the argument. Meanwhile, **D** would actually strengthen the argument's conclusion. Therefore, the answer is **B**. **B** correctly identifies that if those in developed countries use less water, it may be possible for everyone to use the same amount as these people and still be in a sustainable situation.

Question 83: C

There is no mention of treatment, so **A** is incorrect. A need to travel abroad for the post is not stated either, so **B** is incorrect. **D** is tempting, but wrong, as the passage implies those who panic will be bad leaders – not the other way around. Other qualities are irrelevant to the argument, so **E** is also incorrect. **C** would only be relevant if there was indeed a link between 'a specific phobia' and 'a general tendency to panic'. Thus, **C** highlights the flaw: if a fear of flying does not necessitate a general disposition of panic, the argument for not hiring this employee crumbles.

Question 84: C

The passage does not suggest there are no more university places, nor does it make a distinction between the qualities of different universities, so **A** is incorrect, and **D** is irrelevant. The argument does not deny the fact that people can be successful without a university education, so **B** is also wrong. **E is incorrect because it does not suggest who it makes economic sense for, and university cost is to the government.** **C** is correct, as the passage specifically states 'many more graduates', but not all, are equipped with better skills and better earning potential. This suggests not all degrees produce these skillsets in their graduates, and so not all university places will create high-earning employees.

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Question 85: E

B is unrelated to the argument, as other contributing factors would not negate the damaging potential of TV. Watching sport on television would not be akin to actually playing sport, so **A** is also incorrect. The possibility of eye damage is stated as caused by TV, so **C** is incorrect. **D is incorrect, it just says one night of exercise would be preferable.** However, if people watch television and partake in sport, which the passage seems to imply cannot happen, they may not suffer the negative effects of obesity and social exclusion. For example, they may play sport during the day and watch television in the evening, thus experiencing the benefits of exercise and also enjoying the sedentary activity. Therefore, various potential threats supposedly posed by watching excessive television are undermined, and **E** is correct.

Question 86: C

D directly counters the above argument, and so is incorrect. Though **A**, **B** and **D** are all suggested or stated by the passage, they each act as evidence for the main conclusion, **C**, describing the 'multiple reasons to legalise cannabis'.

Question 87: C

C is not an assumption as it has been explicitly stated in the question that the salary is fixed, and therefore it will not change. The rest of the statements are all assumptions that Mohan has made. At no point has it been stated that any of the other statements are true, but they are all required to be true for Mohan's reasoning to be correct. Therefore, they are all assumptions Mohan has made.

Question 88: A

The answer is not **B** because, although the Holocaust was a tragedy, this is not explicitly stated in the passage. It cannot be **C** or **E**, as these are also not directly stated above. **D** provides an intermediary conclusion that leads to the main conclusion of **A**: we should not let terrible things happen again, and through teaching we can achieve this, so therefore 'we should teach about the Holocaust in schools'.

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Question 89: C

DVDs are irrelevant – though one could access disturbing material through a DVD, this does not mean the material seen on TV is less disturbing. The argument also is not concerned with adults, and the suggestion is that violence in any quantity may have a detrimental effect, even if a show is not entirely made up of it. **A, B** and **D** are thus not the correct answers. **C** contradicts the argument, as it suggests there is no link between witnessing and re-enacting what one has witnessed.

Question 90: C

A is irrelevant, as the passage states it could teach children, not that it necessarily would. **B** and **D** are also irrelevant, as the entertainment quality of the show or the likeability of its protagonist would not undermine the logic of the argument. **C** is the correct answer, as it shows how the question uses one model of success and projects it onto all other models, which is illogical: just because Frank succeeds without morality, does not mean all others must reject morality to succeed.

Question 91: A

B, **C**, **D** and **E** are all irrelevant to Freddy's argument that he cannot say a sexist thing because he is a feminist. The woman's discomfort, Neil's feminist stance, the appropriateness of making comments about men, or lewd comments in general do not affect his claim. The presumed link between the two (inability to say something sexist, and feminist self-description) is the flaw in Freddy's argument: someone may believe in equal rights for the genders, and still say a sexist thing.

Question 92: A

At no point is it stated or implied that car companies should prioritise profits over the environment, so **C** is incorrect. Neither is it stated that the public do not care about helping the environment, so **E** is incorrect. **B** is a reason given in the argument, whilst **D** is impossible if we accept the argument's reasons as true, so neither of these are conclusions. However, **A** is correct as the passage argues that cars that use less petrol are less powerful, and so are less attractive to customers, and so companies will sell fewer of them.

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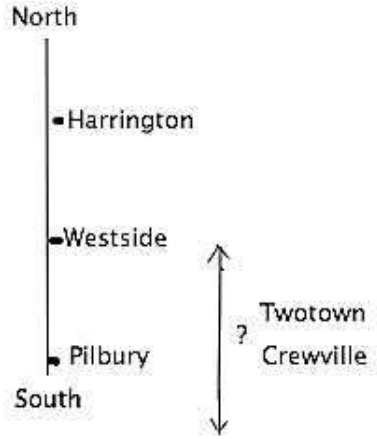
Question 93: D

The easiest thing to do is draw the relative positions. We know Harrington is north of Westside and Pilbury. We know that Twotown is between Pilbury and Westside. Crewville is south of Twotown, Westside and Harrington but we do not know its location relative to Pilbury.



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Question 94: B

By making a grid and filling in the relevant information the days Dr James works can be deduced:

	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
Dr Evans	No	Yes	No	No	Yes	Yes	Yes
Dr James	No	Yes	Yes	Yes	Yes	No	Yes
Dr Luca	No	No	Yes	Yes	No	Yes	Yes

No one works Sunday, but all work Saturday. Dr Evans works Mondays and Fridays but cannot work 4 days consecutively, so he cannot work Wednesday. This means Dr James and Luca must work Wednesday. Dr Luca cannot work Monday or Thursday so, Dr James works Monday. Dr Evans and Dr James must work Thursday. Dr Evans only works 4 days, so cannot work Tuesday, which means Dr James and Luca work Tuesday. Dr James cannot work 5 days consecutively so cannot work Friday, which means Dr Luca must work Friday. From the completed table, we see Dr James works on Monday, Tuesday, Wednesday, Thursday and Saturday, so **B** is the answer.

Question 95: E

Work algebraically, using the call out rate as C, and rate per mile as M.

So, C + 4m = 11

C + 5m = 13

Hence; (C + 5m) – (C + 4m) = £13 - £11

M = £2

Substituting this back into C + 4m = 11

C + (4 x 2) = 11

Hence, C = £3

Thus, a ride of 9 mile will cost £3 + (9 x £2) = £21.

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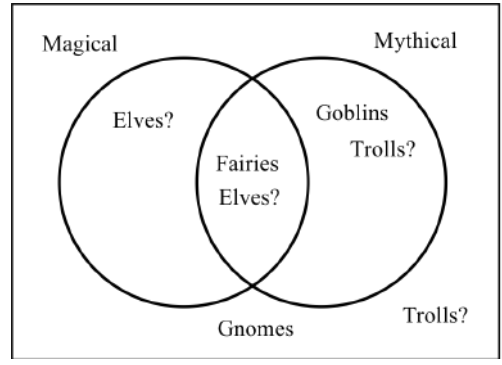
Question 96: E

Use the information to create a Venn diagram.



We don't know the exact position of trolls and elves, so **A** and **D** are true. Goblins are mythical but not magical, so **C** is true. Gnomes are neither so **B** is true. But **E** is not true, because we know the positions of gnomes and goblins, and they are not the same.

Question 97: D

The best method may be to work backwards from 7pm. The packing (15 minutes) of all 100 tiles must have started by 6:45pm, so the cooling (20 minutes) of the last 50 tiles is started by 6:25pm, and the heating (45 minutes) by 5:40pm. The first 50 heating (45 minutes) must have started by 4:35pm, and cooling (20 minutes) by 5:20pm. The decoration (50 minutes) of the second 50 can occur anytime during 4:35pm- 5:40pm as this is when the first 50 are heating and cooling in the kiln, and so does not add time. The first 50 take 50 minutes to decorate and so must be started by 3:45pm.

Question 98: D

There are three outcomes from choosing the type of cheese in the crust. For each of the 7 additional possible toppings, there are 2 outcomes: 1 to include and another not to include a certain topping.

Thus, the number of different kinds of pizza is: $3 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 3 \times 2^7 = 3 \times 128 = 384$

Question 99: E

Using the months of the year, Melissa could be born in March or May, Jack in June or July and Alina in April or August. With the information that Melissa and Jack's birthdays are 3 months apart, the only possible combination is March and June. Hence Alina must be born in August, which means it is another 7 months until Melissa's birthday in March.

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Question 100: A

PC Bryan cannot work with PC Adams because they have already worked together for 7 days in a row, so **C** is incorrect. **B** is incorrect because if PC Dirk worked with PC Bryan that would leave PC Adams with PC Carter who does not want to work with him. PC Carter can work with PC Bryan.

Question 101: C

Paying for my next 5 appointments will cost £50 per appointment before accounting for the 10% reduction, so the cost counting the deduction is £45 per appointment.

So, the total for 4 appointments = 5 x £45 = £225 for the hair.

Then add £15 for the first manicure and £10 x 2 for the subsequent manicures using the same bottle of polish, bringing an overall total of £225 + £15 + £20 = £260.

Question 102: D

Eli is married to Alex or David, but we are told that Bailey is married to David and so Alex must be married to Eli. Hence David, Bailey, Eli and Alex are the four adults. Bailey and David's child is Gemma. So, Charlie and Frankie must be Alex and Eli's two children. This leaves **D** as the correct answer.

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Question 103: C

Using, x (minutes) as the time taken to do the shortest examination, we can use the information given to create a table.

	1st Student	Changeover	2nd Student	Change over	3rd Student
1st examination	4x	1	2x	1	2x
Break	8 minutes				
2nd examination	x	1	x	1	x

The total time taken is 45minutes (14:30-15:15)

$4x + 2x + 2x + x + x + x + 1 + 1 + 8 + 1 + 1 = 45$

$11x + 12 = 45$

$11x = 33$

$x = 3$

So the second student must have taken 6 minutes to do the examination for the first time.

Question 104: D

The amount of change given is £5 - (2 x £1.65) = £1.70. First, it is easiest to work out which coin we have three of. It cannot be £1 it would be too large. 50p, 20p and 10p coins could not be repeated, as you could not make 20p, £1.10 or £1.40 without repeating any other coins. 5p would also not work, as 3 of those would give 15p, so you would need a fourth 5p coin to make the total add to a multiple of 10. You would run into the same issue if 2p coins were used, so we know we must have three 1p coins.

Now, focus on making a multiple of 10. If you add one 2p coin and a 5p coin, we have 10p, leaving us with 3 coins to make £1.60. This we can do easily with 10p, 50p and £1. This means the coins we have received are three 1p coins, a 2p, a 5p, a 10p, a 50p and a £1. We do not receive a 20p, so **D** is the answer.

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Question 105: D

If we express the speed of each train as W ms^{-1}, then the relative speed of the two trains is 2W ms^{-1}.

Using Speed = Distance / Time:

2W = (140 + 140)/ 14.

Thus, 2W = 20, and W = 10.

The speed of each train is 10 ms^{-1}.

To convert from metres to kilometres, divide by 1,000. To convert from seconds to hours, divide by 3,600.

Therefore, the conversion factor is to divide by 1,000/3,600 = 10/36 = 5/18

Thus, to convert from ms^{-1} to kmph, multiply by 18/5.

Therefore, the final speed of the train is 18/5 x 10 = 36km/hr.

Question 106: C

Taking the day to be 24 hours long, this means the first tap fills 1/6 of the pool in an hour, the second 1/48, the third $\frac{1}{72}$ and the fourth $\frac{1}{96}$.

Taking 288 as the lowest common denominator, this gives: $\frac{48}{288} + \frac{6}{288} + \frac{4}{288} + \frac{3}{288} = \frac{61}{288}$ full in one hour. Hence the pool will be $\frac{244}{288}$ full in 4 hours.

The pool fills by approximately $\frac{15}{288}$ every 15 minutes.

In 4 Hours 15: $\frac{244 + 15}{288} = \frac{249}{288}$

In 4 Hours 30: $\frac{244 + 30}{288} = \frac{274}{288}$

In 4 Hours 45: $\frac{244 + 45}{288} = \frac{289}{288}$

The pool has just filled after 4 hours and 45 minutes, so the answer is **C**.

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Question 107: B

Every day up until day 28 the ant gains a net distance of 1cm, so at the end of day 27 the ant is at 27cm height and therefore only 1cm below the top. On day 28, the 3cm the ant climbs in the day is enough to take it to the top of the ditch and so it is able to climb out**.**

Question 108: A

To solve this question three different sums are needed to use the information given to deduce the costs of the various items.

30 oranges cost £12

£12 / 30 = 40p per orange with the 20% discount, hence oranges must cost 50p at full price.

5 sausages and 10 oranges cost £8.50.

We know that the oranges at a 10% discount account for 10 x 45p = £4.50.

5 undiscounted sausages cost £4, so each full price sausage is £4/5 = 80p.

Finally, we know that 10 sausages and 10 apples cost £9.

At 10% discount, the sausages cost 72p each, accounting for 10 x 72p = £7.20 of the £9.

The 10 apples at a 10% discount must cost £1.80, so each apple costs 18p at 10% discount.

So, an apple is 20p full price.

Now to add up the final total: 2 oranges + 13 sausages + 2 apples = (2 x 50p) + (13 x 72p) + (12 x 18p) = <u>£12.52.</u>

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Question 109: C

If we take the number of haircuts per year to be x, the information we have can be shown in a table:

Membership	Annual Fee	Cost per cut	Total Yearly cost
None	None	£60	60x
VIP	£125	£50	£125 + 50x
Executive VIP	£200	£45	£200 + 45x

As we know that changing to either membership option would cost the same for the year, we can express the cost for the year, y as.

VIP: y = £125 + 50x

Executive VIP: y = £200 + 45x

£125 + 50x = £200 + 45x

5x = £75

x = 15.

Substituting in x, we can therefore work out:

Membership	Annual Fee	Cost per cut	Total Yearly cost
None	None	£60	£900
VIP	£125	£50	£875
Executive VIP	£200	£45	£875

Hence the amount saved by buying membership is £25**.**

Question 110: B

All thieves are criminals. So, the circle must be fully inside the square. We are told judges cannot be criminals so the star must be completely separate from the other two.

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Question 111: C

We are told that March and May have the same last number, which must be either 3 or 13. Taking the information from the question that one of the factors is related to the letters of the month names, we can interpret that 13 represents the M, which starts both March and May. Therefore, we know the rule is that the last number is the position of the starting letter.

Knowing that there is another factor about the letters of the month that controls the code, we can work out that one of the numbers may code for the number of letters. March has 5 letters, which is the second number, so we have the rule of the 2nd number. Finally, through observation we may note that the first number codes for the months' relative position in the year. Hence the code of April will be 4, (for its position), 5 (for the number of letters in the name) and 1 for the position of the starting letter 'A'), and so 451 is the code.

Question 112: D

If *b* is the number of years older than 5, and *a* is the number of A*s, the money given to the children can be expressed as:

£5 + £3b + £10a

Josie receives £5 + (£3 x 11) + (£10 x 9) = £128

We know that Carson receives £44 less yearly, and his b value is 13, so his amount can be expressed as:

£5 + (£3 x 13) + (£10a) = £84

£44 + £10a = £84

a = 4

So, Carson received 4 A* grades, 5 less than Josie.

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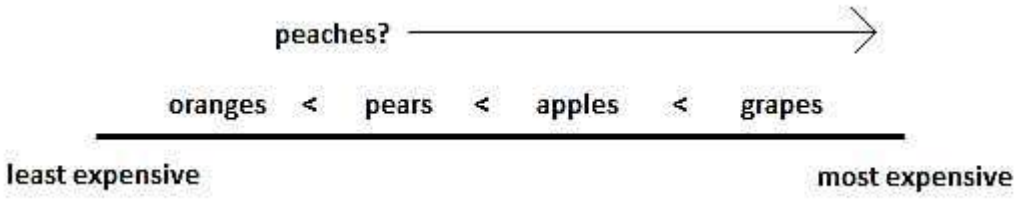
Question 113: C

Using the information to make a diagram:



Hence **A** is incorrect. **D** and **E** may be true, but we do not have enough information to say for sure. **C** must be true as grapes are more expensive than apples so they must be more expensive than pears.

Question 114: B

It's easy to assume all the cuts should be in the vertical plane as a cake is usually sliced, however there is a way to achieve this with fewer cuts. Only three cutting motions are needed**.** Start by cutting in the horizontal plane through the centre of the cake to divide the top half from the bottom half. Then slice in the vertical plane into quarters to give 8 equally sized pieces with just three cuts.

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Question 115: B

This question is made much easier if you look at the options. **B** and **C** are contradictory – if one is true, the other must be false. This means all we need to do is work out if the three arrive at the same time or not. Looking at **D**, which we know must be true because only **B** or **C** is the false statement, we know that Mark arrives early. Tom arrives at 12 PM on time, as stated in **A**, so we know that Mark arrives before Tom, so the friends do not arrive at the same time, so **B** is the answer. If you attempted to work out the time each friend arrived, the explanation for that is given below.

After the changes have been made, at 12 PM (GMT +1):

- Russell thinks it is 11 AM
- Tom thinks it is 12 PM
- Mark thinks it is 1 PM

Thus, in current GMT+1 time zone, Mark will arrive an hour early at 11 AM, Russell an hour late at 1 PM and Tom on time at 12 PM. There is therefore a two-hour difference between the first and last arrival. For option **E**, be careful: the timezone listed is **NOT** GMT +1 that everyone else is working in. 1PM in GMT +3 = 11am GMT +1 (the summer timezone just entered), so that is Mark's actual arrival time.

Question 116: D

Using Bella's statements, as one of them must be true, we know that it was definitely either Charlotte or Edward. If we look at Darcy, she says it must have been Bella or Charlotte. Consequently, as Charlotte's name appears twice, and it can't be both Edward and Bella, we know Charlotte must be the culprit.

Question 117: E

The only way to measure 0.1 litres or 100ml, is to fill the 300ml beaker, pour into the 500 ml beaker, fill the 300ml again and pour (200ml) into the 500ml. This will fill the 500ml beaker, leaving 100ml left in the 300ml beaker. The process requires 600ml of solution to fill the 300ml beaker twice.

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Question 118: D

Be careful of making assumptions in this question – houses on a normal street may start from 0, but that is not necessarily the case here. To work out Francis' house number, we need to first know the number of houses in the street. If you divide 870 by the number of houses, you can find the number of the house in the middle, and then work your way out. For example, if there are only 5 houses, then the middle house must be numbered 870 / 5 = 174. The houses are numbered consecutively with even numbers, so then you could work out that the house numbers are 170, 172, 174, 176 and 178. However, to know where Francis' house is exactly, you would also need its relative position – so if it was second last on the street with 5 houses, it would be number 176. This means statements **1** and **2** are correct, so the answer is **D**.

Question 119: D

Expressed through time:

Event	People Present
There were 20 people exercising in the cardio room.	20
Four people were about to leave.	20
A doctor was on the machine beside him (one of the original 20).	20
Emerging from his office, one of the personal trainers called an ambulance. (+1)	21
Half of the people who were leaving, left. (-2)	19
Eight people came into the room. (+8)	27
The two paramedics arrived. (+2)	29
The man was pronounced dead. (-1)	28

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Question 120: B

Blood loss can be described as 0.2 L/min.

For the man:

8 litres – 40% (3.2 L) = 4.8 L. When he collapses, he has a blood volume of 4.8L and he takes 16 minutes (3.2 / 0.2 = 16) to collapse.

For the woman:

7 litres – 40% (2.8L) = 4.2. When she collapses, she has a blood volume of 4.2 L and she takes 14 minutes (2.8 / 0.2 = 14)

Hence the woman collapses 2 minutes before the man, so **B** is correct, and **A** is incorrect. The total blood loss is 3.2L + 2.8L = 6L so **C** is incorrect. The man's blood loss is 3.2L when he collapses so **E** is incorrect. The woman has a remaining blood volume of 4.2L when she collapses so **D** is incorrect.

Question 121: B

Work out the time taken by each girl – (distance/pace) x 60 (converts to minutes) + lag time to start

Jenny: (13/8) x 60 = 97.5 minutes

Helen: (13/10) x 60 + 15 = 93 minutes

Rachel (13/11) x 60 + 25 = 95.9 minutes

Helen arrives first, followed by Rachel, then Jenny comes last.

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Question 122: C

Work through each statement and the true figures.

A. False. The overlap of pain and flu-like symptoms must be at least 4% (56 + 48 - 100).
   4% of 150: 0.04 x 150 = 6
B. False. 30% complained of high blood pressure and 20% of diabetes, so the maximum percentage complaining of both must be 20%.
   20% of 150 = 0.2 x 150 = 30 patients
C. True. The total number of patients – (Patients complaining of high blood pressure + of diabetes) = 150 – (0.56 x 150 + 0.3 x 150) = 21
D. False. This is a trap that you might fall into if you added up the percentages and noted that the total was greater than 100%. However, this isn't a problem as patients can discuss two problems.

Question 123: C

This is easiest to work out if you give all products an original price – I have used £100. You can then work out the higher price, and the subsequent sale price, and thus the discount from the original £100 price. As the price increases and decreases are in percentages, they will be the same for all items regardless of the price, so it does not matter what the initial figure you start with is.

Marked up price: 100 x 1.15 = £115

Sale price: 115 x 0.75 = £86.25

Percentage reduction from initial price is 100 – 86.25 = 13.75%

Question 124: D

For everyone to have three pancakes, Steve needs to make enough mix for 45 pancakes. The original recipe makes 12, so Steve must make 45 / 12 = 3.75 times the recipe to have enough mix. 2 eggs are used initially, so Steve needs at least 7 ½ eggs, ruling out **A** and **B**. 375g of flour are needed (3.75 x 100 = 375 g) and 1125 ml of milk is required (300 x 3.75 = 1125 ml). These are the quantities listed in **C**. However, the question also states that the first pancake will go wrong, so using these measurements would leave someone with only two pancakes. This means we need to go to the measurements that are the next highest, so **D** is the correct answer.

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Question 125: B

Work through the question backwards.

In 6 litres of diluted bleach, there are 4.8 litres of water and 1.2 litres of partially diluted bleach.

In the 1.2 litres of partially diluted bleach, there is 9 parts water to one-part original warehouse bleach. Remember that a ratio of 1:9 means 1/10 bleach and 9/10 water. Therefore, working through, 120ml of warehouse bleach is needed.

Question 126: C

We know that Charles is born in 2002, therefore in 2010 he must be 8. There are 3 years between Charles and Adam, and Charles is the middle grandchild. As Bertie is older than Adam, Adam must be younger than Charles, so Adam must be 5 in 2010. In 2010, if Adam is 5, Bertie must be 10 (Mrs Smith states he is double the age of Adam). The question asks for ages in 2015: Adam = 10, Bertie = 15, Charles = 13

Question 127: B

Make the statements into algebraic equations and then solve them as you would simultaneous equations. Let a denote the flat fixed rate for hire, and b the price per half hour.

Cost = a + b (time in mins / 30)

Peter: a + 6b (6 half hours) = 14.50 (equation 1)

Kevin: 2a + 18b = 41, or this can be simplified to a + 9b = 20.5 (equation 2)

If you subtract equation 1 from equation 2:

3b = 6, therefore b = 2

Substitute b into either equation to calculate a.

Using equation 1, a + 12 = 14.50, therefore a = 2.50

Finally use these values to work out the cost for 2 hours:

2.50 (flat fee) + 4 x 2 (4 half hours x cost / half hour) = £10.50

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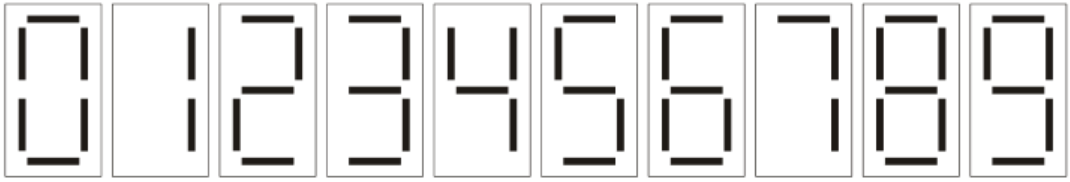
Question 128: E

It is most helpful to write out all the numbers from 0 – 9 in digital format to most easily see which light elements are used for each number. You can then cross out any numbers which don't use all the lights from the digit 7.



Go through the digits methodically and you can cross out: 1, 2, 4, 5, and 6. These numbers don't contain all three bars from the digit 7.

Question 129: B

In this question it is worth remembering it will take more people less time.

Work out how many man hours it takes to build the house by calculating Days x Hours x Builders

12 x 7 x 4 = 336 hours

Work out how many hours it will take the 7-man workforce: 336 / 7 = 48 hours

Convert to 8-hour days: 48 / 8 = 6 days

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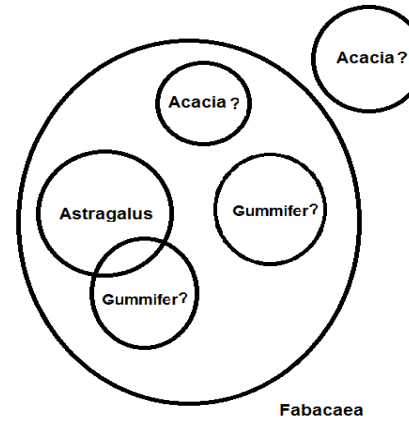
Question 130: D

By far the easiest way to do this type of question is to draw a Venn diagram (use question marks if you are unsure about the exact position):



Now, it is a case of going through each statement:

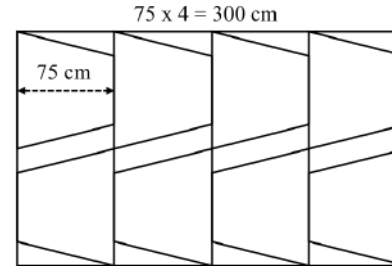
A. Incorrect – Acacia may be fabacaea. Acacia are not astragalus, but it does not logically follow that they therefore can't be fabacaea.
B. Incorrect – astragalus and gummifer are not necessarily separate within fabacaea.
C. Incorrect – the statement is not reversible so the fact that all astragalus and gummifer are fabacaea does not mean all facacaea are gummifer and/or astragalus. E.g. Fabacaea could be acacia.
D. Correct
E. Incorrect – Whilst some acacia could be gummifer, there is no certainty that they are.

Question 131: D

Area of a trapezium = h x (a + b) / 2

Area of cushion = h x (50 + 30) / 2 = 2000 cm^2

Since each width of fabric is 1m wide, both sides of one cushion can fit into one width, if you arrange it as shown in the diagram.



The required length is 75 x 4 = 3m with a cost of 3 x 10 = £30.

Cost of seamstress = £25 x 4 = £100

Total cost is £130.

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Question 132: C

There are 30 days in September, so Lisa will buy 30 coffees.

In Milk, every 10th coffee is free, so Lisa will pay for 27 coffees at £2.40 = £64.80

In Beans, Lisa gets 20 points each day and needs 220 points to get a free coffee, which is 11 days, with 5 points left over. Therefore, in 30 days she will get 2 free coffees. The cost for 28 coffees at £2.15 is £60.20

Beans is cheaper, and the difference is £64.80 - £60.20 = £4.60.

Question 133: C

Work backwards and take note of how often each bus comes.

Paula must get off the 220 bus at 10.57 at the latest. She could therefore get the 10.40 bus, as she would arrive at 10.54. The latest she can get on the 283 bus is 10.15, so as to make the 220 bus connection. 283 comes every 10 mins (the question doesn't state at what minute past the hour), so Paula should be at the bus stop at 10.06 to ensure a bus comes by 10.15 at the latest. If the bus comes every 10mins, even if a bus comes at 10.05 which Paula will miss, the next bus will come at 10.15 and therefore she will still be on time.

Therefore, Paula must leave at 10.01

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Question 134: B

You are working out the time taken to reach the same distance (D). Make sure to take into account changing speeds of train A, and that train B leaves 20 minutes earlier.

Speed = $\frac{\text{distance}}{\text{time}}$

Make sure you keep the answers consistent in the time units you are using, the worked answer is all in minutes (hence the need to multiply by 60).

Train A: time for first 20km = $\frac{20}{100}$ x 60 = 12 minutes

So, the distance where it equals B is 12 + ($\frac{D - 20}{150}$) x 60

You need to use D - 20 to account for the fact you have already calculated the time at the slower speed for the first 20km

Train B: ($\frac{D}{90}$) x 60 – 20

Make the equations equal each other as they describe the same time and distance and solve.

12 + ($\frac{D - 20}{150}$) x 60 = ($\frac{D}{90}$) x 60 – 20

This simplifies to 32+ $\frac{2D}{5}$ – 8 = $\frac{2D}{3}$

So D = 90km

Train B will take 60 minutes to travel 90 km and train A will take 40 minutes (but as it leaves 20 minutes later, this will be point at which it passes).

Question 135: C

Work out the annual cost of local gym: 12 x 15 = £180

Upfront cost + class costs of university gym must therefore be > £180.

Subtract upfront cost to find number of classes: 180 – 35 = £145

Divide by cost per class (£3) to find number of classes: 145/3 = 48 1/3

48 1/3 classes would make the two gyms the same price, so for the local gym to be cheaper, you would need to attend 49 classes.

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Question 136: C

A is definitely true, since the question states that all herbal drugs are not medicines. **B** is also definitely true as all antibiotics are medicines, which are all drugs. **C** is definitely false, because all antibiotics are medicine, yet no herbal drugs are medicines. **D** is true as all antibiotics are medicines.

Question 137: C

Answer **A** cannot be reliably concluded, because from the information given a non-"fast" train could stop at Newark, but not at Northallerton or Durham. We have no information on whether all trains stopping at Newark also stop at Northallerton. Answer **B** is not correct because 8 is the average number of trains that stop at Northallerton. It is possible that on some days more than 16 trains run, and more than 8 will thus stop at Northallerton. Answer **D** is incorrect because it is mentioned that all trains stopping at Northallerton also stop at Durham, giving a total 6 stops as a minimum for a train stopping at Northallerton (the others being the 4 stops which all trains stop at). Answer **E** is incorrect for a similar reason to **A**. We have no information on whether all trains stopping at Newark also stop at Northallerton, so cannot determine that they must also stop at Durham.

Answer **C** is correct because "fast" trains make less than 5 stops. Since all trains already stop at 4 stops (Peterborough, York, Darlington and Newcastle), they cannot then stop at Durham, as this would give 5 stops.

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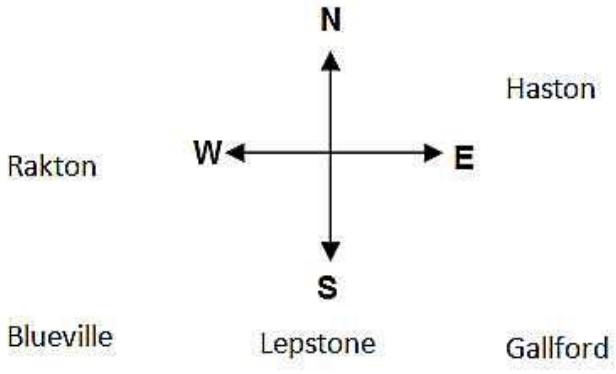
Question 138: D

From the information we are given, we can compose the following image of how these towns are located (not to scale, but shows the direction of each town with respect to the others):



From this "map", we can see that all statements apart from **D** are true. Statement **D** is definitely not true, since Blueville is south west of Haston it cannot be East of Haston.

Question 139: C

We are told that in order to form a government, a party (or coalition) must have over 50% of seats. Thus, they must have at least 50% of the total seats plus 1, which is 301 seats.

We are told that we are looking for the minimum number of seats the Green party can have in order to form a coalition with Red and Orange. Thus, we are seeking for Red and Orange to have the maximum number of seats possible, under the criteria given.

Thus, we can calculate as follows:

- No party has over 45% of seats, so the maximum that the Red party can have is 45%, which is 270 seats.
- No party except for Red and Blue has won more than 4% of seats. We are told that the Green party won the 4th highest number of seats, so it is possible that the Orange party won the 3rd highest. (*cont. overleaf*)

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- Thus, the maximum number of seats the Orange party can have won is 4% of the total, which is 24 seats.
- Thus, the maximum possible combined total of the Red and Orange party's seats won is 294.

Thus, in order to achieve a total of 301 seats in a Red-Orange-Green coalition, the Green party have to have won at least 7 seats. However, in addition, to satisfy the criteria of the Green party coming 4th place they must have won the majority of the remaining 36 seats giving a final breakdown of votes as: Red 270, Blue 270, Orange 24, Green 13, Yellow 12, Purple 11.

Question 140: E

Expressing the amount each child receives:

Youngest	*M*
2nd youngest	M + D
3rd youngest/ 3rd oldest	M + 2D
4th youngest/ 2nd oldest	M + 3D
Oldest	M + 4D

Question 141: D

The total amount of money received:

£100 = M + M + D + M + 2D + M + 3D + M + 4D

£100 = 5M + 10D

Question 142: C

The two youngest are expressed as M+ M + D = 2M + D.

The three oldest are expressed as M + 2D + M + 3D + M + 4D = 3M + 9D

Hence 7 times the two youngest together is expressed 7(2M + D), so altogether the answer is:

7(2M + D) = 3M + 9D.

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Question 143: A

To work this out, simplify the two equations:

$7(2M + D) = 3M + 9D$

$14M + 7D = 3M + 9D$

$11M = 2D$

$M = \frac{2D}{11}$

Question 144: A

Substitute M into the equation £ 100 = 5M + 10D

$5\left(\frac{2D}{11}\right) + 10D = £100$

$\frac{10D}{11} + 10D = \frac{10D}{11} + \frac{110D}{11} = \frac{120D}{11}$

Question 145: E

The easiest way to work this out is using a table. With the information already given we know:

1st		Madeira
2nd		
3rd	Jaya	
4th		

Ellen made carrot cake and it was not last. It cannot be 1st or 3rd as these places are taken so it must be second:

1st		Madeira
2nd	Ellen	Carrot cake
3rd	Jaya	
4th		

Aleena's was better than the tiramisu, so she can't have come last, therefore Aleena must have placed first. (*cont. overleaf*)

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1st	Aleena	Madeira
2nd	Ellen	Carrot cake
3rd	Jaya	
4th		

And the girl who made the Victoria sponge was better than Veronica:

1st	Aleena	Madeira
2nd	Ellen	Carrot cake
3rd	Jaya	Victoria Sponge
4th	Veronica	Tiramisu

Question 146: D

The information given can be expressed to show the results that the teams must have had to make their points total.

Team	Points	Game Results			
Celtic Changers	2	L	L	D	D
Eire Lions	?	?	?	?	?
Nordic Nesters	8	W	W	D	D
Sorten Swipers	5	W	D	D	L
Whistling Winners	1	D	L	L	L

The results so far total 3 wins, 6 losses and 7 draws. Since the number of draws must be even, there must have been another draw. So, we know one of the Eire Lions results is a draw.

The difference between wins (3) and losses (6) is 3. Thus, there must be another 3 wins to account for this difference. So, the Eire Lions results must be 3 wins and 1 draw. Thus, they scored $3 \times 3 + 1 = 10$.

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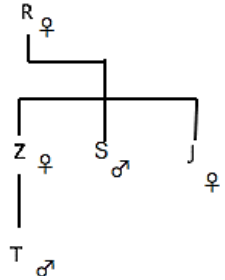
Question 147: D

Remember to consider the gender of each person. Draw a quick diagram to show the given information, and you can see that only **D** is correct**.**

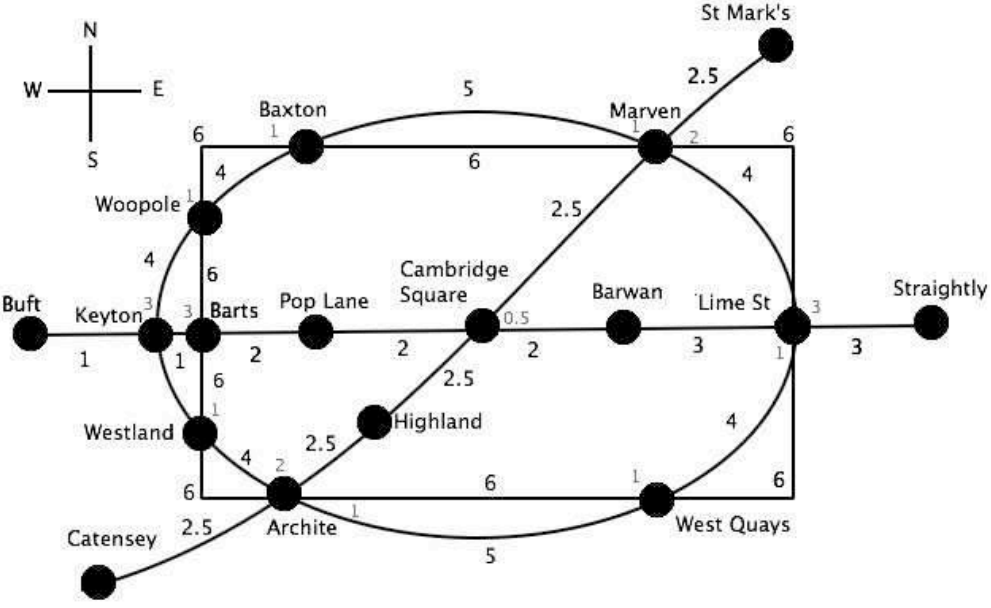


Question 148: B

After the first round, he knocks off 8 bottles to leave 8 left on the shelf. He then puts back 4 bottles. There are now 12 left on the shelf. After the second round, he has hit 3 bottles and damages 6 bottles in total, and an additional 2 at the end. He then puts up 2 new bottles to leave 12 – 8 + 2 = 6 bottles left on the shelf. After the final round, John knocks off 3 bottles from the shelf to leave 3 bottles standing.

Question 149: D

Based on the information we have we can plot the travel times below. Changeover times are in a smaller font.



Hence on the St Mark's line, St Mark's to Archite takes 4 x 2.5 minutes = 10 minutes**.**

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Question 150: A

Going from stop to stop on the Straightly line from Buft to Straightly would take 14 minutes, but we are told earlier on there is an express train that goes end to end and only takes 6.

Question 151: B

The quickest route from Baxton to Pop Lane is via Marven and Cambridge Square, which takes 5 + 2 + 2.5 + 0.5 + 2 = 12 minutes. Baxton to Pop Lane via Barts would take 4 + 1 + 6 + 3 + 2 = 16 minutes, which is longer, so **E** is incorrect. Other options include times failing to take account of, or incorrectly adding, changeover times, and so are incorrect.

Question 152: C

From Cambridge Square:

- Catensey is (2.5 x 3 =) 7.5 minutes away.
- Woopole, is (4 + 3 + 1 +2 + 2 =) 12 minutes.
- Buft is (1 + 1 + 2 + 2 =) 6 minutes.
- Westland is (4 + 2 + 2.5 + 2.5 =) 11 minutes.

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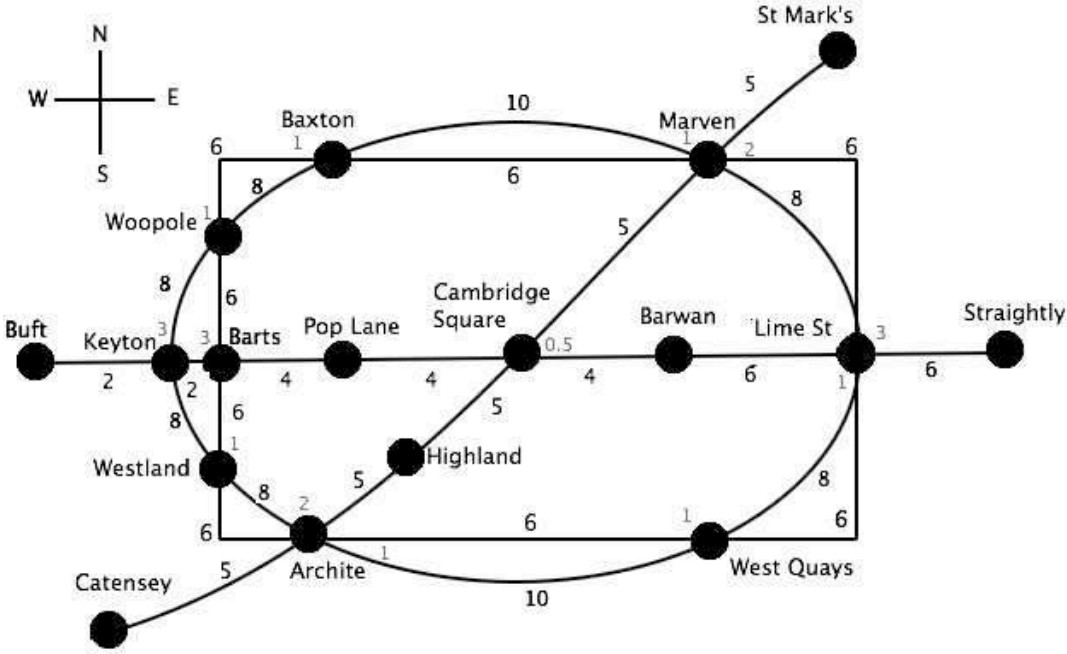
Question 153: B

With the new delay information, we can plot the travel times as before, adjusted for the delays. Plus, a 5-minute delay on the platforms when waiting on any platform for a train.



The quickest way from Westland to Marven now uses the non-delayed reliable rectangle line. Four stops on the rectangle line take 6 mins each, so 24 minutes in total on the train. Add to this the additional 5 minutes platform waiting time to give a total journey time of 29 minutes.

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Question 154: C

- Baxton to Archite via Barts using only the Rectangle line takes 5 + 6 + 6 + 6 + 6 = 29 minutes.
- Baxton to Woopole on the Rectangle line, then Oval to Archite via Keyton takes 5 + 6 + 1 + 5 + 8 + 8 + 8 = 41 minutes
- Baxton to Archite on the Oval line only takes 5 + (8 x 4) = 37 minutes
- Baxton to Woopole on the Oval line, then Rectangle to Archite via Barts takes 5 + 8 + 1 + 5 + 6 + 6 + 6 = 37 minutes
- As the bus takes 27-31 minutes, it is not possible to tell from between the options which will be slower or quicker, so option **C** is the right answer.

Question 155: D

Remember the 5-minute platform wait. We are not told that the St Mark's express train from end to end is no longer running so we must assume that it is, which takes 5 minutes (plus the wait at St Mark's to go to Catensey).

Then, there is a 5-minute wait at Catensey to Archite, and a 2 + 5-minute changeover at Archite onto the Rectangle line, which then takes 6 minutes to West Quays. 5 + 5 + 5 + 5 + 2 + 5 + 6 = 33 minutes. Via Lime St, the journey takes 5 + 5 + 5+ 2 + 5 + 6 + 6 = 29 minutes.

Question 156: D

From the information:

- "Simon's horse wore number 1."
- "...the horse that wore 3, which was wearing red..."
- "the horse wearing blue wore number 4."

We can plot the information below:

Place	Owner	Number	Colours
	Simon	1	
		2	
		3	Red
		4	Blue

In addition, "The horse wearing green; Celia's, came second", means Celia's horse must have worn number two, because it cannot have worn number 1 as that is Simon's horse. Also, it cannot have worn number three or four because they wore red and blue respectively. So, we can plot this further deduction:

Place	Owner	Number	Colours
	Simon	1	
2nd	Celia	2	Green
		3	Red
		4	Blue

We also know that

- "Arthur's horse beat Simon's horse"
- "Celia's horse beat the horse that wore number 1." i.e. Simon's.

We know Celia's horse came second, and that both Celia's and Arthur's horses beat Simon's. This means that Simon's horse must have come last. So:

Place	Owner	Number	Colours
4th	Simon	1	
2nd	Celia	2	Green
		3	Red
		4	Blue

And knowing that:

- "Only one horse wore the same number as the position it finished in."

The horses wearing numbers 3 and 4 must have placed 1st and 3rd respectively. Hence:

Place	Owner	Number	Colours
4th	Simon	1	
2nd	Celia	2	Green
1st		3	Red
3rd		4	Blue

"Lila's horse wasn't painted yellow nor blue"

So, Lila's must have been red, and Simon's yellow. Leaving the only option for Arthur's to be blue. So, we now know:

Place	Owner	Number	Colours
4th	Simon	1	Yellow
2nd	Celia	2	Green
1st	Lila	3	Red
3rd	Arthur	4	Blue

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Question 157: C

- Year 1 – 40 x 1.2 = 48
- Year 2 – 48 x 1.2 = 57.6
- Year 3 – 57.6 x 1.1 = 63.36
- Year 4 – 63.36 x 1.1 = 69.696.

Question 158: C

To minimise the total cost to the company, they want the wage bills for each site to be less than £200,000. Working this out involves some trial and error; you can speed this up by splitting employees who earn similar amounts between the sites e.g. Nicola and John as they are the top two earners.

Nicola + Daniel + Luke = £ 198,500 and John + Emma + Victoria = £ 199,150

Question 159: C

Remember that pick up and drop off stops may be the same stop, therefore the minimum number of stops the bus had to make was 7. This would take 7 x 1.5 = 10.5 minutes.

Therefore, the total journey time = 24 + 10.5 = 34.5 minutes.

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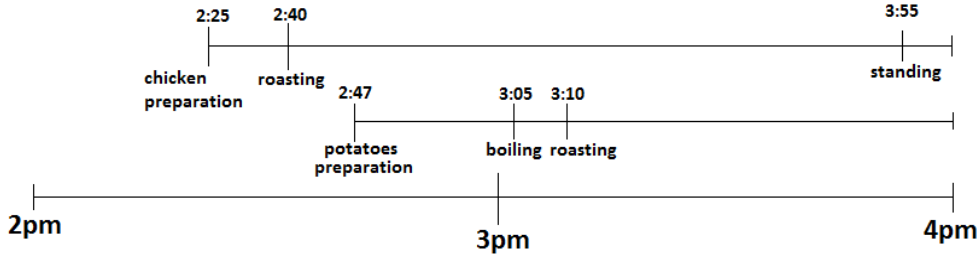
Question 160: A

The best method here is to work backwards. We know the potatoes have to be served immediately, so they should be finished roasting at 4pm, so they should start roasting 50 minutes prior to that, at 3:10. We also know they have to be roasted immediately after boiling, so they should be prepared by 3:05, in order to boil in time. She should therefore start preparing them no later than 2:47, though she could prepare them earlier. The chicken needs to be cooked by 3:55 to give it time to stand, so it should begin roasting at 2:40, and Sally should begin to prepare it no later than 2:25.

You can construct a rough timeline:



We can see from this timeline that from 2:40 onwards, there will be no long enough period of time in which there is a free space in the cooker for the vegetables to be boiled. They therefore must be finished cooking at 3:05. The latest time prior to this that Sally has time to prepare them (5 minutes) is at 2:40, between preparing the chicken and the potatoes. She should therefore begin preparing the vegetables at 2:42, then begin boiling at 2:47, so they can be finished cooking by 2:55, in time for the potatoes to boil at 3:05.

Therefore, the final times that Sally must start to cook each item are:

- Chicken: 2:25
- Potatoes: 2:47
- Vegetables: 2:42

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Question 161: C

The quickest way to do this is via trial and error. However, for the sake of completion: let each child's age be denoted by the letter of their name, and form an equation for their total age:

$P + J + A + R = 80$

The age of each child can be written in terms of Paul's age.

$P = 2J$, therefore $J = \frac{P}{2}$

$A = \frac{P+J}{2}$

Now substitute in $J = \frac{P}{2}$ to get in terms of P only: $A = \frac{P+\frac{P}{2}}{2} = \frac{P}{2} + \frac{P}{4} = \frac{3P}{4}$

$R = P+2$

Thus: $P + \frac{P}{2} + \frac{3P}{4} + P (+ 2) = 80$

Simplify to give: $\frac{13P}{4} = 78$

$13P = 312$

Thus, $P = 24$

Substitute $P = 24$ into the equations for the other children to get: $J = 12$, $A = 18$, $R = 26$

Question 162: A

The total number of buttons is 71 + 86 + 83 = 240. The total number of suitable buttons is 22 + 8 = 30. Thus, she will have to remove a maximum of 210 buttons in order to guarantee picking a suitable button on the next attempt.

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Question 163: E

This question requires you to calculate the adjusted score for Ben for each segment. If Ben has a 50% chance of hitting the segment he is aiming for, we can assume he hits each adjacent segment 25% of the time. Thus: Adjusted Score = $\frac{\text{Segment aimed at}}{2} + \frac{\text{First Adjacent Segment}}{4} + \frac{\text{Second Adjacent Segment}}{4}$

Adjusted Score = $\frac{\text{Segment aimed at}}{2} + \frac{\text{Sum of Adjacent Segments}}{4}$

E.g. if he aims at segment 1: He will score $\frac{1}{2} + \frac{18+20}{4} = 10$

Now it is a simple case of trying the given options to see which segment gives the highest score. In this case, it is segment 19: $\frac{19}{2} + \frac{7+3}{4} = 12$

Question 164: C

The total cost is £8.75, and Victoria uses a £5.00 note, leaving a total cost of £3.65 to be paid using change.

Up to 20p can be paid using 1p and 2p pieces, so she could use twenty 1p coins to make up this amount.

Up to 50p can be paid using 5p and 10p pieces, so she could use ten 5p pieces to make up this amount. This gives a total of 30 coins, and a total payment of £0.70.

Up to £1.00 can be paid using 20p pieces and 50p pieces. Thus, she could use up to five 20p pieces, giving a total of 35 coins used, and a total payment of £1.70.

The smallest denomination of coin that can now be used is a £1.00 coin. Hence Victoria must use two £1.00 coins, giving a total of 37 coins, and a total payment of £3.70. However, we know that the total cost to pay in change was £3.65, and that Victoria paid the exact amount, receiving no change. Thus, we must take away coins to the value of 5p, removing the smallest number of coins possible. This is achieved by taking away 1 5p piece, giving a grand total of 36 coins.

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Question 165: B

The time could be 21:25, if first 2 digits were reversed by the glass of water (21 would be reversed to give 15). **A** cannot be the answer, because this would involve altering the last 2 digits, and we can see that 25 on a digital clock, when reversed simply gives 25 (the 2 on the left becomes a 5 on the right, and the 5 on the right becomes a 2 on the left). **C** cannot be the answer, as this involves reversing the middle 2 digits. As with the right two digits, the middle 2 digits of 2:5 would simply reverse to give itself, 2:5. **D** could be the time if the 2nd and 4th digits were reversed, as they would both become 2's. However, the question says that 2 adjacent digits are reversed, meaning that the 2nd and 4th digits cannot be reversed as required here. **E** is not possible as it would require all four numbers to be reversed.

Thus, the answer is **B**.

Question 166: B

We can see from the question that Lorkdon is a democracy and therefore cannot have been invaded by a democracy because of the treaty (we are assuming this treaty is upheld, as said in the question). Thus, Nordic (which has invaded Lorkdon) must be a dictatorship. Now, we can see that Worsid has been invaded by a dictatorship and has invaded a dictatorship. The question states that no dictatorship has undergone both of these events. Thus, we know that Worsid cannot be a dictatorship. We also know from the question that each of these countries is either a dictatorship or a democracy. Thus, Worsid must be a democracy.

Question 167: C

The total price of all of these items would usually be £17. However, with the DVD offer, the customer saves £1, giving a total cost of £16. Thus, the customer will need to receive £34 in change.

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Question 168: B

To answer this, we simply calculate how much total room in the pan will be taken up by the food for each guest:

- 2 rashers of bacon, giving a total of 14% of the available space.
- 4 sausages, taking up a total of 12% of the available space.
- 1 egg takes up 12% of the available space.

Adding these figures together, we see that each guest's food takes up a total of 38% of the available space. Thus, Ryan can only cook for 2 guests at once, since 38% multiplied by 3 is 114%, and we cannot use up more than 100% of the available space in the pan.

Question 169: C

To calculate this, let the total number of employees be termed "Y".

We can see that £60 is the total cost for providing cakes for 40% of "Y".

We know that £2 is required for each cake. Thus, we can work out that 30 must be 40% of Y.

$0.4Y = 60/2$

$0.4Y = 30$

$Y = 75$

Thus, we can calculate that the total number of employees must be 75.

Question 170: E

The normal waiting time for treatment is 3 weeks. However, the higher demand in Bob's local district mean this waiting time is extended by 50%, giving a total of 4.5 weeks.

Then, we must consider the delay induced because Bob is a lower risk case, which extends the waiting time by another 20%. 20% of 4.5 is 0.9, so there is a delay of another 0.9 weeks for treatment.

Thus, Bob can expect to wait 5.4 weeks for specialist treatment on his tumour.

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Question 171: D

In the class of 30, 40% drink alcohol at least once a month, which is 12. Of these, 75% drink alcohol once a week, which is 9. Of these, 1 in 3 smoke marijuana, which is 3.

60% drink alcohol less than once a month, which is 18. Of these, 1 in 3 smoke marijuana, which is 6.

Therefore, the total number of students who smoke marijuana is 3+6, which is 9.

Question 172: C

The sequence can either be thought of as doubling the previous number then adding 2 or adding 1 then doubling. Double 46 is 92, plus 2 is 94.

Question 173: B

If the mode of 5 numbers of 3, it must feature at least two threes. If the median is 8, we know that the 3rd largest number is an 8. Hence, we know that the 3 smallest numbers are 3, 3, and 8. Because the mean is 7, we know that the 5 numbers must add up to 35. The three smallest numbers add up to 14. Hence the two largest must add up to 21.

Question 174: E

The biggest difference in the weight of potatoes will be if the bag with only 5 potatoes in weighs the maximum, 1100g, and the bag with 10 potatoes weighs the minimum, 900g. If there are 5 equally heavy potatoes in a bag weighing 1100g, each weighs 220g. If there are 10 equally heavy potatoes in a 900g bag, each weighs 90g. The difference between these is 130g.

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Question 175: D

There are 60 teams, and 4 teams in each group, so there are 15 groups. In each group, if each team plays each other once, there will be 6 matches in each group, making a total of 90 matches in the group stage. There are then 16 teams in the knockout stages, so 8 matches in the first-round knockout, then 4, then 2, then 1 final match when only two teams are left. Hence there are 105 matches altogether (90 + 8 + 4 + 2 + 1 = 105).

Question 176: A

We know the husband's PIN number must be divisible by 8 because it has been multiplied by 2 three times and had a multiple of 8 added to it. The largest 4-digit number which is divisible by 8 is 9992. 9992 - 200 = 9792

9792 / 2 = 4896

Hence the largest the husband's last 4 card digits can be is 4896.

4896 - 200 = 469.

4696 / 2 = 2348

Hence the largest my last 4 card digits can be is 2348.

2348 – 200 = 2148

2148 / 2 = 1074

Hence the largest my PIN number can be is 1074.

Question 177: C

If the first invitation is sent as early as possible, it will be sent on the 50th birthday. It will be accepted after 2 reminders and conducted at 50 years 11 months. The time between each screening will be 3 years 11 months. Hence, the second screening will be at 54 years 10 months. The third screening will be at 58 years 9 months, so the fourth screening will be at 62 years 8 months.

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Question 178: A

Ellie has worked for the company for more than five, but less than six, whole years. At the end of each whole year she receives a pay rise in thousands equal to the number of years of her tenure. Therefore, at the end of the first year the raise is £1,000, then at the end of the second year it is £2,000 and so on to year 5. Thus, the total amount of her pay comprised by the pay rises is £15,000, so the basic pay before accounting for these rises was £40,000 - £15,000 = £25,000.

Question 179: B

The trains come into the station together every 40 minutes, as the lowest common multiple of 2, 5 and 8 is 40. Hence, if the last time trains came together was 15 minutes ago, the next time will be in 25 minutes.

Question 180: C

If you smoke, your risk of getting Disease X is 1 in 24. If you drink alcohol, your risk of getting Disease X is 1 in 6. Each tablet of the drug halves your risk. Therefore, a drinker taking 1 tablet means their risk is 1 in 12 and taking 2 tablets means their risk is 1 in 24, the same as someone who smokes.

Question 181: A

There are 10 red and 8 green balls. Clearly, the most likely combination involves these colours only. Since there are more red balls than green, the probability of red-red is greater than green-green. However, there are **two** possible ways to draw a combination, either the red first followed by green or green first followed by red.

The probability of red-red = $\left(\frac{10}{20}\times\frac{9}{19}\right)=\frac{9}{38}$.

The probability of red and green = $\left(\frac{8}{20}\times\frac{10}{19}\right)+\left(\frac{10}{20}\times\frac{8}{19}\right)=\frac{8}{38}+\frac{8}{38}=\frac{16}{38}$. Therefore, the combination of red and green is more likely.

Question 182: B

The least likely combination of balls to draw is blue and yellow. You are much more likely to draw a green ball than either a blue or yellow one because there are many more in the bag. Since the draw is taken without replacement, yellow and yellow is impossible because there is only one yellow ball.

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Question 183: E

Since there is only 1 blue and 1 yellow ball, it is possible to take 18 balls which are red or green. You would need to take 19 of the 20 balls to be certain of getting either the blue ball or the yellow ball.

Question 184: C

The smallest number of parties required would theoretically be 3 – Namely Labour, the Liberal Democrats and UKIP, giving a total of 355 seats. However, the Liberal Democrats will not form a coalition with UKIP, so this will not be possible. Thus, there are 2 options:

- Labour can form a coalition with the Greens and UKIP, which is not contradictory to anything mentioned in the question. This would give a total of 325 seats and would need the next 2 largest parties (The Scottish National Party and Plaid Cymru) in order to get more than 350 seats, meaning 5 parties would need to be involved.
- Alternatively, Labour can form a coalition with the Liberal Democrats and the Green Party. This would give a total of 340 seats. Only one more party (e.g. the Scottish National Party) would be required to exceed 350 seats, giving a grand total of 4 parties.

Thus, the smallest number of parties needed to form a coalition would be 4.

Question 185: E

360 appointments are attended and only 90% of those booked are attended, meaning there were originally 400 appointments booked in and 40 have been missed. 1 in 2 of the booked appointments were for male patients, so 200 appointments were for male patients. Male patients are three times as likely to miss booked appointments, so of the 40 that were missed, 30 were missed by men. Given that of 200 booked appointments, 30 were missed, this means 170 were attended by men.

Question 186: B

If every one of 60 students studies 3 subjects, this is 180 subject choices altogether. 60 of these are Maths, because everyone takes Maths. 60% of 60 is 36, so 36 are Biology. 50% of 60 is 30, so 30 are Economics and 30 are Chemistry. 60 + 36 + 30 + 30 = 156, so there are 24 subject choices left which must be Physics.

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Question 187: B

If 100,000 people are diagnosed with chlamydia and 0.6 partners are informed each, this is 60,000 people, of which 80% (so 48,000) have tests. 12,000 of the partners who are informed, as well as 240,000 who are not (300,000 – 60,000) do not have tests. This makes 252,000 who are not tested. We can assume that half of these people would have tested positive for chlamydia, which is 126,000. So, the answer is 126,000.

Question 188: C

Tiles can be added at either end of the 3 lines of 2 tiles horizontally or at either end of the 2 lines of 2 tiles vertically. This is a total of 10, but in two cases these positions are the same (at the bottom of the left-hand vertical line and the top of the right-hand vertical line). So, the answer is 10 – 2 = 8.

Question 189: C

Harry needs a total of 4000ml + 1200ml = 5200ml of squash. He has 1040ml of concentrated squash, which is a fifth of the total dilute squash he needs. So, he will need 4 parts water to every 1 part of concentrated squash, therefore the resulting liquid is 1/5 squash and 4/5 water.

Question 190: C

There are 24 different possible arrangements (4 x 3 x 2 x 1), which means that there are 23 other possible arrangements than Alex, Beth, Cathy, Daniel.

Question 191: E

A is incorrect because the distance travelled is only 10 miles. **B** is incorrect because the distance travelled is 19 miles. **C** is incorrect because no town is visited twice. **D** is incorrect because Hondale and Baleford are both visited twice. Therefore, **E** is the correct answer.

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Question 192: C

Georgia is shorter than her Mum and Dad, and each of her siblings is at least as tall as Mum (and we know Mum is shorter than Dad because Ellie is between the two), so we know Georgia is the shortest. We know that Ellie, Tom and Dad are all taller than Mum, so Mum is second shortest. Ellie is shorter than Dad and Tom is taller than Dad, so we can work out that Ellie must be third shortest.

Question 193: A

Danielle must be sat next to Caitlin. Bella must be sat next to the teaching assistant. Hence these two pairs must sit in different rows. One pair must be sat at the front with Ashley, and the other must be sat at the back with Emily. Since the teaching assistant has to sit on the left, this must mean that Bella is sat in the middle seat and either Ashley or Emily (depending on which row they are in) is sat in the right-hand seat. However, Bella cannot sit next to Emily, so this means Bella and the teaching assistant must be in the front row. So, Ashley must be sat in the front right seat.

Question 194: C

The dishwasher is run 2 + p times a week, where p is the number of people in the house. Let the number of people in the house when the son is not home be s, and when the son is home it is s + 1. In the 30 weeks when the son is home, she would buy 6 packs of dishwasher tablets. In 30 weeks when the son is not home, she would buy 5 packs of dishwasher tablets. So, 1.2 times as many packs of dishwasher tablets are bought when he is home.

So, $2 + s + 1 = 1.2\ (2 + s)$

$2.4 + 1.2s = 2 + s + 1$

Therefore, $0.2s = 0.6$

$s = 3$

When her son is home, there are $s + 1 = 4$ people in the house.

Question 195: A

No remaining days in the year obey the rule. The next date that does is 01/01/2015 (integers are 0, 1, 2, 5). This is 6 days later than the specified date.

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Question 196: B

If each town is due north, south, east or west of at least 2 other towns and we know that one is east and one is north of a third, then they must be arranged in a square. So Yellowtown is 4 miles east of Bluetown to make a square, which means it must be 5 miles north of Redtown. So Redtown is 5 miles south of Yellowtown.

Question 197: B

Jenna pours 4/5 of 250 ml into each glass, which is 200 ml. Since she has 1500 ml of wine, she pours 100 ml into the last glass, which is 2/5 of the 250 ml full capacity.

Question 198: E

The maximum number of girls in Miss Ellis's class with brown eyes and brown hair is 10, because the two thirds of the girls with brown eyes could also all have brown hair. The minimum number is 0 because it could be that all the boys, and the third of the girls without brown eyes, all had brown hair, which would be 2/3 of the class.

Question 199: E

A negative "score" results from any combination of throws which includes a 1 but from no other combination. Given that a negative score has a 0.75 probability, a positive or zero score has a 0.25 probability. Therefore, throwing two numbers that are not 1 twice in a row has a probability of 0.25. Hence, the probability of throwing a non-1 number on each throw is $\sqrt{0.25} = 0.5$. So, the probability of throwing a 1 on an individual throw is $1 - 0.5 = 0.5$.

Question 200: C

We can work out from the information given the adult flat rate and the charge per stop. Let the charge per stop be s and the flat rate be f.

$15s + f = 1.70$

$8s + f = 1.14$

We can then work out that $7s = 0.56$, so $s = 0.08$. Hence, f = £0.50

Megan is an adult, so she pays this rate. For 30 stops, the rate will be $0.08 \times 30 + 0.50$ = £2.90.

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Question 201: B

We found in the previous question that the flat rate for adults is £0.50 and the rate per stop is £0.08. We know that the child rate is half the flat rate and a quarter of the "per stop" rate, so the child flat rate is £0.25 and the rate per stop is 2p. So, for 25 stops, Alice pays:

0.02 x 25 + 0.25 = 0.75

Question 202: C

We should first work out how many stops James can travel. For £2, he can afford to travel as many stops as £1.50 will take him once the flat rate is taken into account. The per stop rate is 8p per stop, so he can travel 18 stops, so he will need to go to the 18th stop from town. So, he will need to walk past 7 stops to get to the stop he can afford to travel from.

Question 203: D

The picture will need a 12-inch by 16-inch mount, which will cost £8. It will need a 13-inch by 17-inch frame, which will cost £26. So, the cost of mounting and framing the picture will be £8 + £26 = £34.

Question 204: C

Mounting and framing an 8 by 8-inch painting will cost £5 for the mount and £22 for the frame, which is £27. Mounting and framing a 10 by 10-inch painting will cost £6 for the mount and £26 for the frame, which is £32. The difference is £32 - £27 = £5.

Question 205: B

We found in the last question that mounting and framing a 10 by 10-inch painting will cost £6 for the mount and £26 for the frame, which is £32 total. We can calculate that each additional inch of mount and frame for a square painting costs £2.50: £2 for the frame and £0.50 for the mount. So, an 11-inch painting will cost £34.50 to frame and mount, a 12 inch £37, a 13 inch £39.50, a 14 inch £42. The biggest painting that can be mounted and framed for £40 is a 13-inch painting.

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Question 206: D

Recognise that the pattern is that consonants move forward by two consonants and vowel stay the same. This allows coding of the word MAGICAL to PAJIFAN to RALIHAQ.

- M ⇒ O (skips to) P ⇒ R
- A ⇒ Stays the same ⇒ A
- G ⇒ I (skips to) J ⇒ L
- I ⇒ Stays the same ⇒ I
- C ⇒ E (skips to) F ⇒ H
- A ⇒ Stays the same ⇒ A
- L ⇒ N ⇒ Q

Question 207: C

If f donates the flat rate, and k denotes the rate per km, we can form simultaneous equations:

f + 5k = £6 and f + 3k = £4.20

Subtract equation two from equation one:

(f + 5k) - (f + 3k) = £6 - £4.20

Thus, 2k = £1.80 and k = £0.90

Therefore, f + (5 x 0.90) = £6

So, f + £4.50 = £6. Thus, f = £1.50

7k will be £1.50 + 7 x £0.90 = £7.80

Question 208: C

The increase from 2001/2 to 2011/12 was 1,019 to 11,736, which equals a linear increase of 10,717 admissions.

So, in 20 years, we would expect to see an increase by 10,717 x 2 = 21,434. Add this to the number in 2011 to give 33,170 admissions.

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Question 209: A

As the question uses percentages, it does not matter what figure you use. To make calculations easier, use an initial price of £100. When on sale, the dress is 20% off, so using a normal price of £100, the dress would be £80. When the dresses are 20% off, the shop is making a 25% profit. Therefore: £80 = 1.25 x purchase price.

Therefore, the purchase price is: $\frac{80}{1.25}$ = £64. Thus, the normal profit is £100 - £64 = £36. I.e. when a dress sells for £100, the shop makes £36 or 36% profit.

Question 210: C

1. Incorrect. There must be 6 general committee clinical students, plus the treasurer, and 2 sabbatical roles, none of whom can be preclinical, so there must be a maximum of 11 preclinical students.
2. Correct. There must two general committee students for each year plus welfare and social officers, totalling to 6.
3. Incorrect. The committee is made up of 20 students, 2 roles are sabbatical, so there are 18 studying students, and therefore there can be 3 from each year.
4. Correct. There are 18 studying students on the committee, and there must be 6 general committee members from pre-clinical, plus welfare and social, therefore there must be a minimum of 8 pre-clinical students, so there must be 10 clinical students.
5. Incorrect. You need to count up the number of specific roles on the committee, which is 5, and there must be 2 students from each year, which is 12. This leaves 3 more positions, which the question doesn't state can't be first years. Therefore, there could be up to 5 first years.
6. Incorrect. There must be at least 2 general committee members from each year. However, the worked answer to 5 shows there are 15 general committee members which are split across the 6 years, and so there must be an uneven distribution.

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Question 211: B

Remember 2012 was a leap year. Work through each month, adding the correct number of days, to work out what day each 13th would be on. If a month was 28 days, the 13th would be the same day each month, so to work this out quickly, you only need to count on the number of days over 28. For example, in a month with 31 days, the 13th will be 3 weekdays (31-28) later.

Thus, if 13th January is a Friday, 13th February is a Monday, (February has 29 days in 2012), 13th March is a Tuesday and 13th April is a Friday.

Question 212: E

There are 18 sheep in total. The question states there are 8 male sheep, which means there are 10 female sheep before some die. 5 female sheep die, so there are 5 female sheep alive to give birth to lambs. Each delivers 2 lambs, making 10 lambs in total. There are 4 male sheep and 5 mothers, so the total is 10 + 4 + 5 = 19 sheep.

Question 213: D

We can see from the fact that all the possible answers end "AME" that the letters "AME" must be translated to the last 3 letters of the coded word, "JVN", under the code. J is the 10th letter of the alphabet, so it is 9 letters on from A (V is the 21st letter of the alphabet and M is the 13th, and N is the 14th letter of the alphabet and E is the 5th, therefore these pairs are also 9 letters apart). Therefore, P is the code for the letter 9 letters before it in the alphabet. P is the 16th letter of the alphabet, so it is the code for the 7th letter of the alphabet, G. Therefore, from these solutions, the only possibility for the original word is GAME.

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Question 214: C

Let x be the number of people who get on the bus at the station.

It is easiest to work backwards. After the 4th stop, there are 5 people on the bus. At the 4th stop, half the people who were on the bus got off (and therefore half stayed on) and 2 people got on. Therefore, 5 is equal to 2 plus half the number of people who were on the bus after the 3rd stop. So, half the number of people who were on the bus after the 3rd stop must be 3. Therefore, after the 3rd stop, there must have been 6 people on the bus.

We can then say that 6 is equal to 2 plus half the number of people who were on the bus after the 2nd stop. Therefore, there were 8 people on the bus after the 2nd stop.

We can then say that 8 is equal to 2 plus half the number of people who were on the bus after the 1st stop. Therefore, there were 12 people on the bus after the 1st stop.

We can then say that 12 is equal to 2 plus half the number of people who got on the bus at the station. Therefore, the number of people who got on the bus at the station is 20.

Question 215: B

We know from the question that I have purchased small cans of blue and white paint, and that blue paint accounted for 50% of the total cost. Since a can of blue paint is 4 X the price of a can of white paint, we know I must have purchased 4 cans of white paint for each can of blue paint.

Each can of small paint covers a total of $10m^2$, and I have painted a total of $100m^2$, in doing so using up all the paint. Therefore, I must have purchased 10 cans of paint. Therefore, I must have purchased 2 cans of blue paint and 8 cans of white paint. So, I must have painted $20m^2$ of wall space blue.

Question 216: E

The cost for x cakes under this offer can be expressed as: $x\ (42 - x^2)$

Following this formula, we can see that 2 cakes would cost 76p, 3 cakes would cost 99p, and 4 cakes would cost 104p. As the number of cakes increases beyond 4, we see that the overall price actually drops, as 5 cakes would cost 85p and 6 cakes would cost 36p. This confirms Isobel's prediction that the offer is a bad deal for the baker, as it ends up cheaper for the customer to purchase more cakes. It is clear that 6 cakes is the smallest number for which the price will be under 40p, and the price will continue to drop as more cakes are purchased.

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Question 217: C

Adding up the percentages of students in University A who do "Science" subjects gives:

23.50 + 6.25 + 30.25 = 60%.

60% of 800 students is 480, so 480 students in University A do "Science" subjects.

Adding up the percentages of students in University B who do "Science subjects" gives:

13.25 + 14.75 + 7.00 = 35%. 35% of 1200 students is 420, so 420 students in University B do "Science" subjects. Therefore:

480 – 420 = 60

60 more students in University A than University B take a "Science" subject.

Question 218: C

Let the number of miles Sonia is travelling be x. Because she is crossing 1 international border, travelling by Traveleasy Coaches will cost Sonia: £ (5 + 0.5x)

Travelling by Europremier coaches will cost Sonia: £ (15 + 0.1x).

Because we know the cost is the same for both companies, the number of miles she is travelling can be found by setting these two expressions equal to each other:

5 + 0.5x = 15 + 0.1x.

This equation can be rearranged to give: 0.4x = 10

Therefore: x = 10 / 0.4 = 25

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Question 219: E

To find out whether many of these statements are true it is necessary to work out the departure and arrival times, and journey time, for each girl.

Lauren departs at 2:30pm and arrives at 4pm, therefore her journey takes 1.5 hours

Chloe departs at 1:30pm and her journey takes 1 hour longer than 1.5 hours (Lauren's journey), therefore her journey takes 2.5 hours and she arrives at 4pm

Amy arrives at 4:15pm and her journey takes 2 times 1.5 hours (Lauren's journey), therefore her journey takes 3 hours and she departs at 1:15pm.

Looking at each statement, the only one which is definitely true is **E**: Amy departs at 1:15pm and Chloe departs at 1:30pm therefore Amy departed before Chloe.

D *may* be true, but nothing in the question shows it is *definitely* true, so it can be safely ignored.

Question 220: B

First consider how many items of clothing she can take by weight. The weight allowance is 20kg. Take off 2kg for the weight of the empty suitcase, then take off another 3kg (3 X 1000g) for the books she wishes to take. Therefore, she can fit 15kg of clothes in her suitcase. To find out how many items of clothing this is, we can divide 15kg = 15000g by 400g: 15000 / 400 = 150 / 4 = 37.5

So, she can pack up to 37 items of clothing by weight.

Now consider the volume of clothes she can fit in. The total volume of the suitcase is:

50cm x 50cm x 20cm = 50000cm^3

The volume of each book is: 0.2m x 0.1m x 0.05m = 1000cm^3

So, the volume of space available for clothes is: 50000 – (3 x 1000) = 47000cm^3

To find out how many items of clothing she can fit in this space, we can divide 47000 by 1500:

47000 / 1500 = 470 / 15 = 31 1/3

So, she can pack up to 31 items of clothing by volume.

Although she can fit 37 items by weight, they will not fit in the volume of the suitcase, so the maximum number of items of clothing she can pack is 31.

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Question 221: D

We can work out the answer by considering each option:

Bed Shop A: £120 + £70 = £190

Bed Shop B: £90 + £90 = £180

Bed Shop C: £140 + (1/2 x £60) = £170

Bed Shop D: (2/3) x (£140 + £100) = (2/3) x (£240) = £160

Bed Shop E: £175

Therefore, the cheapest is Bed Shop **D**.

Question 222: C

The numbers of socks of each colour is irrelevant, so long as there is more than one of each (which there is). There are only 4 colours of socks, so if Joseph takes 5 socks, it is guaranteed that at least 2 of them will be the same colour.

Question 223: D

Paper comes in packs of 500, and with each pack 20 magazines can be printed. Each pack costs £3.

Card comes in packs of 60, and with each pack 60 magazines can be printed. Each pack costs £3 x 2 = £6.

Each ink cartridge prints 130 sheets, which is 130/26 = 5 magazines. Each cartridge costs £5.

The lowest common multiple of 20, 60 and 5 is 60, so it is possible to work out the total cost for printing 60 magazines. Printing 60 magazines will require 3 packs of paper at £3, 1 pack of card at £6 and 12 ink cartridges at £5. So, the total cost of printing 60 magazines is: (3 x 3) + 6 + (12 x 5) = £75.

The total budget is £300.

£300/£75 = 4

So, we can print 4 x 60 magazines with this budget, which is 240 magazines.

Question 224: E

We can express the information we have as: $\frac{1}{4} - \frac{1}{5} = \frac{1}{20}$

So, the six additional lengths make up 1/20 of Rebecca's intended distance. So, the number of lengths she intended to complete was: 20 x 6 = 120.

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Question 225: B

Sammy has a choice of 3 flavours for the first sweet that he eats. Each of the other sweets he eats cannot be the same flavour as the sweet he has just eaten. So, he has a choice of 2 flavours for each of these four sweets. So, the total number of ways that he can make his choices is: $3 \times 2 \times 2 \times 2 \times 2 = 48$

Question 226: C

Suppose that today Gill is x years old. It follows that Granny is 15x years old. In 4 years' time, Gill will be (x + 4) years old and Granny will be 15x + 4 years old. We know that in 4 years' time, Granny's age is equal to Gill's age squared, so: $15x + 4 = (x + 4)^2$

Expanding and rearranging, we get: $x^2 - 7x + 12 = 0$

We can factorise this to get: (x - 3) (x - 4)

So, x is either 3 or 4. Gill's age today is either 3 or 4 so Granny is either 45 or 60. We know Granny's age is an even number, so she must be 60 and hence Gill must be 4. So, the difference in their ages is 56 years.

Question 227: C

If Pierre is telling the truth, everyone else is not telling the truth. But, also in this case, what Qadr said is not true, and hence Ratna is telling the truth. So, we have a contradiction. So, we deduce that Pierre is not telling the truth. Therefore, Qadr is telling the truth, and so Ratna is not telling the truth. So, Sven is also telling the truth, and hence Tanya is not telling the truth. So Qadr and Sven are telling the truth and the other three are not telling the truth.

Question 228: D

Angus walks for 20 minutes at 3 mph and runs for 20 minutes at 6 mph. 20 minutes is one-third of an hour. So, the number of miles that Angus covers is: $3 \times 13 + 6 \times 13 = 6$

Bruce covers the same distance. So, Bruce walks 12×3 miles at 3 mph which takes him 30 minutes and runs the same distance at 6 mph which takes him 15 minutes. So altogether it takes Bruce 45 minutes to finish the course.

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Question 229: B

Although you could do this quickly by forming simultaneous equations, it is even quicker to note that 72 x 4 = 288. Since Species 24601 each have 4 legs; it leaves a single member of species 8472 to account for the other 2 legs.

Question 230: E

None of the options can be concluded for certain. We are not told whether any chicken dishes are spicy, only that they are all creamy. Whilst all vegetable dishes are spicy, some non-vegetable dishes could also be spicy. There is no information on whether dishes can be both creamy and spicy, nor on which, if any, dishes contain tomatoes. Remember, if you're really stuck, draw a Venn diagram for these types of questions.

Question 231: C

At 10mph, we can express the time it takes Lucy to get home as: 60 x 8/10 = 48

Since Simon sets off 20 minutes later, his time taken to get home, in order to arrive at the same time, must be: 48 – 20 = 28

Therefore his cycling speed must be: 48/28 x 10 = 17mph

Question 232: A

The total profit from the first transaction can be expressed as: 2000 x 8 = 16,000p

The total profit from the second transaction is: 1000 x 6 = 6,000p

Therefore the total profit is 22,000p or £220 before charges. There are four transactions at a cost of £20 each, so the overall profit is: £220 – (20 x 4) = £140

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Question 233: C

For the total score to be odd, there must be either three odd or one odd and two even scores obtained. Since the solitary odd score could be either the first, second or third throw there are four possible outcomes that result in an odd total score. Additionally, there are the same number of possibilities giving an even score (either all three even or two odd and one even score obtained), and the chance of throwing odd or even with any given dart is equal. Therefore, there is an equal probability of three darts totalling to an odd score as to an even score, and so the chance of an odd score is ½.

Question 234: C

This is a compound interest question. £5,000 must be increased by 5%, and then the answer needs to be increased by 5% for four more iterations. After one year: £5,000 x 1.05 = £5,250

Increasing sequentially gives £5,512, £5,788, £6,077 and £6,381 after five years. Therefore, the answer is £6,381.

Question 235: D

If in 5 years' time the sum of their ages is 62, the sum of their ages today will be: 62 – (5 x 2) = 52

Therefore if they were the same age, they would both be 26, but with a 12-year age gap they are 20 and 32 today. Michael is the older brother, so 2 years ago he would have been aged 30.

Question 236: A

Tearing out every page which is a multiple of 3 removes 166 pages. All multiples of 6 are multiples of 3, so no more pages are torn out with that instruction. Finally, half of the remaining pages are removed, which equates to an additional 167 pages. Therefore 333 pages are removed in total. The total surface area of these pages is 15 x 30 x 333 = 149,850 cm^2 = 14.9m^2. At 110 gm^2, 14.9 m^2 weighs 14.9 x 110 = 1,650g (1,648g unrounded)

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Question 237: D

The cost of fertiliser is 80p/kg = 8p/100g. At 200g, the incremental increase in yield is 65 pence/m. At each additional 100g it will be reduced by 30%, therefore at 300g/m it is 45.5p, at 400g/m it is 31.8p, at 500g/m it is 22.3p, at 600g/m it is 15.6p, at 700g/m it is 10.9p, and at 800g it is 7.6p. So at 800g the gain in yield is less than the cost of the fertiliser to produce the gain, and so it is no longer cost effective to fertilise more.

Question 238: D

Statements **A**, **C** and **E** are all definitely true. Meanwhile, statement **B** may be not true but is not definitely untrue, as this depends on the number of cats and rabbit owned.

Only statement **D** is definitely untrue. The type of animal requiring the most food is a dog, and as can be seen from the tables, Furry Friends actually sells the most expensive dog food, not the cheapest.

Question 239: C

The largest decrease in bank balance occurs between January 1st and February 1st, totalling £171, reflecting the amount spent during the month of January, £1171. However, because there is a pay rise beginning on March 10th, we need to consider that from April onwards, the bank balance will have increased by £1100, not £1000. This means that the same decrease in bank balance reflects £100 more spending if it occurs after March. This means that 2 months now have seen more spending than February. Between March 1st and April 1st, the bank balance has decreased by £139. With the salary increase, the salary is now £1100, so the total spending for the month of March is £1239. This is greater than the total spending during the month of January.

Similarly, the month of April has also seen more spending than January once the pay rise is considered, a total of £1225 of spending. However, this is still less than the month of March.

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Question 240: C

If Amy gets a taxi, she can set off 100 minutes before 17:00, which is 15:20.

If Amy gets a train, she must get the 15:00 train as the later train arrives after 17:00, so she must set off at 1500.

Since Northtown airport is 30 minutes from Northtown station, there is no way Amy can get the flight and still arrive at Northtown station by 17:00. Therefore Amy should get a taxi and should leave at 15:20.

Question 241: C

We can decompose the elements of the multiplication grid into their prime factors, thus:

	C	**D**
A	2 x 2 x 2 x 3 x 7	2 x 2 x 2 x 2 x 3 x 3 x 5
B	7 x 17	2 x 3 x 5 x 17

bc = 7 x 17, so one of **b** and **c** must be 7 and the other must be 17. **b** must be 17 because **bd** is a multiple of 17 and not of 7, and **c** must be 7 because **ac** is a multiple of 7 and not of 17. **ac** is 168, so **a** must be 168 divided by 7, which is 24. **ad** is 720 so **d** must be 720 divided by 24, which is 30. Hence the answer is 30. Alternatively, approach the question by eliminating all answers which are not factors of both 720 and 510.

Question 242: E

48% of the students are girls, which is 720 students. Hence 80 is 1/9 of the girls, so 1/9 of boys are mixed-race. The remaining 780 students are boys, so 87 boys are mixed-race to the nearest person. However, there is a shortcut to this question. Notice that 80 girls are mixed race, and the proportion is the same for boys. As there are more boys than girls, we know the answer is greater than 80. Option **E** is the only option for which this holds true.

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Question 243: D

Don't be fooled – this is surprisingly easy. We can see that between Monday and Thursday, Christine has worked a total of 30 hours. We can also calculate how long her shift on Friday was supposed to be. She is able to make up the hours by working 3 extra hours next week, and 5 hours on Sunday. Thus, the Friday shift must have been planned to be 8 hours long. Adding this to the other 30 hours, we see that Christine was supposed to work 38 hours this week.

Question 244: C

130°. Each hour is 1/12 of a complete turn, equalling 30°. The smaller angle between 8 and 12 on the clock face is 4 gaps, therefore 120°. In addition, there is 1/3 of the distance between 3 and 4 still to turn, so an additional 10° must be added on to account for that.

Question 245: D

If there are 8 pincers, then we know there must be 4 crabs, as starfish have no pincers. This means that 4 x 8 = 32 of the legs are from crabs, leaving 79 – 32 = 47 legs to be from starfish.

One of the starfish lost one leg and regrew 3, so has 7 legs in total. Subtracting that from the 47 legs leaves 40 legs, which corresponds clearly to 8 starfish.

There are 9 starfish and 4 crabs in total, so the difference is 5.

Question 246: E

A. Incorrect. UCL study found eating more portions of fruit and vegetables was beneficial.
B. Incorrect. This is a possible reason but has yet to be fully investigated.
C. Incorrect. Fruit and vegetables are more protective against cardiovascular disease and were shown to have little effect on cancer rates.
D. Incorrect. Inconclusive – people who ate more vegetables generally had a lower mortality but unknown if this is due to eating more vegetables or other associated factors.
E. Correct. Although this has previously been the case, this study did not find so.

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Question 247: C

Deaths in meta-analysis = 56423 / 800000 = 0.07 or 7%
Rate of death was 1% lower in UCL study, so 6%.
6% of 65,000 = 65000 x 0.06 = 3,900

Question 248: B

A. Eating more fruit and vegetables doesn't particularly lower overall cancer risk, but research into whether it can lower the risk of specific cancers is needed.
B. The UCL research alone found that increasing the number of fruit and vegetable portions had a beneficial effect, even though this wasn't the overall conclusion when combined with results from the meta-analysis.
C. The results were not exactly the same but showed similar overall trends.
D. Although this may be true, there is no mention of this in the passage.
E. Fruit and vegetables are protective against cardiovascular disease, but not exclusively. They also reduce the rates of death from all causes.

Question 249: E

Remember that you don't need to calculate exact values for questions **249 – 251**. Thus, you should round numbers frequently to make this more manageable. Work out percentage of beer and wine consumption and then the actual value using the total alcohol consumption figure:

Belarus: 17.3 + 5.2 = 22.5%;
0.225 x 17.5 = 3.94

Lithuania: Missing figure 100 – 7.8 – 34.1 – 11.6 = 46.5
46.5 + 7.8 = 54.3%
0.543 x 15.4 = 8.36

France: 18.8 + 56.4 = 75.2%
0.752 x 12.2 = 9.17

Ireland: 48.1 + 26.1 = 74.2
0.742 x 11.9 = 8.83

Andorra: missing figure 100 – 34.6 – 20.1 = 45.3
34.6 + 45.3 = 79.9%
0.799 x 13.8 = 11.0

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Question 250: D

Russia:
2010 – Total = 11.5+3.6 = 15.1. Spirits = 0.51 x 15.1 = 7.7
2020 – Total = 14.5. Spirits = 0.51 x 14.5 = 7.4
Difference = 0.3 L

Belarus:
2010 – Total = 14.4 + 3.2 = 17.6. Spirits = 0.466 x 17.6 = 8.2
2020 – Total = 17.1. Spirits = 0.466 x 17.1 = 8.0
Difference = 0.2 L

Lithuania:
2010 – Total = 15.4. Spirits = 0.341 x 15.4 = 5.3
2020 – Total = 16.2. Spirits = 0.341 x 16.2 = 5.5
Difference = 0.2 L

Grenada:
2010 – Total = 12.5. Spirits % = 100 – 29.3 – 4.3 – 0.2 = 66.2%. Spirits = 0.662 x 12.5 = 8.3
2020 – Total = 10.4. Spirits = 0.662 x 10.4 = 6.8
Difference = 1.5 L

Ireland:
2010 – Total = 11.9. Spirits = 0.187 x 11.9 = 2.2
2020 – Total = 10.9. Spirits = 0.187 x 10.9 = 2
Difference = 0.2 L

Question 251: C

Work out 4.9 as a percentage of total beer consumption in Czech Republic and search other rows for similar percentage.

4.9/13 = 0.38, approx. 38% which is very similar to percentage consumption in Russia (37.6).

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Question 252: B

We can add up the total incidence of the 6 cancers in men, which is 94,000. Then we can add up the total incidence in women, which is 101,000. As a percentage of 10 million, this is 0.94% of men and 1.01% of women. Therefore the difference is 0.07%.

Question 253: C

Given there are 1.15 times as many men as women, the incidence of each cancer amongst men needs to be greater than 1.15 times the incidence amongst women in order for a man to be more likely to develop it. The incidence is at least 1.15 higher in men for 3 cancers (prostate, lung and bladder).

Question 254: D

If 10% of cancer patients are in Sydney, there are 10,300 prostate/bladder/breast cancer patients and 9,200 lung/bowel/uterus cancer patients in Sydney. Hence the total number of hospital visits is 10,300 + 18,400, which is 28,700.

Question 255: A

The proportion of men with bladder cancer is 2/3 and of women is 1/3.

Question 256: D

First, we work out the size of each standard drink. 50 standard drinks of vodka is equivalent to 1250 ml, so one drink is 25 ml or 0.025 litres. 11.4 standard drinks of beer is 10 pints of 5700ml, so one standard drink is 500ml or 0.5 litres. 3 standard drinks of cocktail is 750ml, so one is 250ml or 0.25 litres. 3.75 standard drinks of wine is 750ml, so one is 200ml or 0.2 litres.

We can then work out the number of units in each drink. Vodka has 0.025 x 40 = 1 unit, Beer has 0.5 x 3 = 1.5 units, Cocktail has 0.25 x 8 = 2 units and Wine has 0.2 x 12.5 = 2.5 units. Since the drink with the most units is wine, the answer is D.

Question 257: B

We found in the last question that vodka has 1 unit, beer has 1.5, cocktail has 2 and wine has 2.5. In the week, Hannah drinks 23.5 units and Mark drinks 29 units. Hence Hannah exceeds the recommended amount by 9.5 units and Mark by 9 units.

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Question 258: D

We found that vodka has 1 unit, beer has 1.5, cocktail has 2 and wine has 2.5. Hence it is possible to make 5 combinations of drinks that are 4 units: 4 vodkas, 2 cocktails, 2 vodkas and a cocktail, 1 vodka and 2 beers, or a wine and a beer.

Question 259: D

The total number of males in Greentown is 12,890. Adding up the rest of the age categories, we can see that 10,140 of these are in the older age categories. Hence there are 2750 males under 20.

Question 260: C

Given that in the first question we found the number of males under 20 is 2,750, we can then add up the totals in the age categories (apart from 40-59) in order to find that 15,000 of the residents of Greentown are in other age categories. Hence 9,320 of the population are aged 40-59. We know that 4,130 of these are male, therefore 5,190 must be female.

Question 261: C

The age group with the highest ratio of males:females is 20-39, with approximately 1.9 males per females (approximately 3800:2000). As a ratio of females to males, this is 1:1.9.

Question 262: C

There are 4 instances where the line for Newcastle is flat from one month to the next per year, hence in 2008-2012 (5 years) there are 20 occasions when the average temperature is the same from month to month. During 2007, there are 2 occasions, and during 2013 there are 3.

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Question 263: A

The average temperature is lower than the previous month in London for all months from August to December, which is 5 months. However, in August and November in Newcastle, the average temperature remains the same as the previous month. Hence there are only 3 months where the average temperature is lower in both cities. Hence from 2007 to 2012, there are 18 months where the average temperature is lower than the previous month. During 2013, the only included month where the temperature is lower in both cities than the previous month is September. Hence there are 19 months in total when the temperature is lower in both cities than the previous month.

Question 264: B

Firstly, work out the difference between average temperatures for each month (2, 3, 1, 2, 1, 3, 3, 2, 2, 5, 1, 0) then sum them to give 25. Divide by the number of months (12) to give $2^{1}/_{12}$, which is 2°C to the nearest 0.5°C.

Question 265: E

There is not enough information to tell which month the highest sales are in. We know it increases up to a point and decreases after it, but as we don't know by how much we cannot project where the maximum sales will be.

Question 266: B

Given that Q2 and Q3 both account for 1/3 of the sales and Q4 accounts for 1/4, this leaves that Q1 accounts for 1/12 of sales. 1/12 of £354,720 is £29,560.

Question 267: A

Quarter 2 accounts for 1/3 of the sales, which is £60,000 in sales revenue. If a tub of ice cream is sold for £2 and costs the manufacturer £1.50, this means profit is 1/4 of sales revenue. Hence £15,000 profit is made during Q2. Hence the answer is A.

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Question 268: D

A and **B** – Incorrect. Both could be true, but neither is definitely true as it is dependent on the relative number of families with each number of children, which is not given in the question. Therefore we cannot know for certain whether these statements are true.

C – Incorrect. **C** is definitely untrue as half of the families spend £400 a month on food, which totals £4800 a year.

D – Correct. This option is true as 1/6 of families with 1 child and 1/6 of families with 3 children spent £100 a month on food.

E – Incorrect. This option is definitely untrue as the average expenditure for families with 2 children is actually £400 a month.

Question 269: B

2210 out of 2500 filled in responses, meaning that 290 did not. 290 as a percentage of 2500 is roughly 12% (11.6%) of the school that did not respond**.**

Question 270: C

The percentage of students that saw bullying and reported it was 35%, so 65% of those who saw it did not, which is equivalent to 725 students. Of this 725, 146, which roughly equals 20%, gave the reason that they did not think it was important.

Question 271: B

Of the students who told a teacher, 286 did not witness any action. Of those who did notice action, 110, only 40% noticed any direct action with the bully involved. 40% of 110 is 44, so the correct answer is **B**.

Question 272: D

"427 cited fears of being found out", which means about 59% out of the 725 students that did not tell about the bullying, cited that it was because they worried about others finding out.

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Question 273: E

North-east: 56 per 100,000 on average. This means that there must be a higher proportion of women than this and a lower proportion of men, such that the average is 56/100,000.

There are the same number of men and women in the population.

Therefore, there are 18.6/50,000 men and 37.3/50,000 women

This scales to 74.4/100,000 women, which is roughly 74/100,000.

Question 274: C

8 million children – question tells to approximate to 4 million girls and 4 million boys.

Girls: 20% eat 5 portions fruit and vegetables a day. 20% of 4 million: 4 x 0.2 = 0.8 million

Boys: 16% eat 5 portions of fruit and vegetables a day. 16% of 4 million: 4 x 0.16 = 0.64 million

Difference: 800,000 – 640,000 = 160,000.

Question 275: B

A. Incorrect. Women: 13619 + 10144 + 6569 = 30332. Men: 16818 + 9726 + 7669 + 6311 = 40524
B. Correct. Flu + pneumonia, lung cancer and chronic lower respiratory diseases = 15361 + 13619 + 14927 = 43907
C. Incorrect. More common cause of death but no information surrounding prevalence.
D. Incorrect. Colon cancer ranks 8 for both men and women.
E. Incorrect, the table discusses mortality, not who gets cancer.

Question 276: A

The government has claimed a 20% reduction, so we are looking for an assessment criterion which has reduced 20% from 2013 to 2014. We can see that only "Number of people waiting for over 4 hours in A&E" has reduced by 20%, so this must be the criterion the government has used to describe "waiting times in A&E". Thus, the answer is **A**.

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Question 277: B

Rovers must have played 10 games overall as they played each other team twice. They lost 9 games, scoring no points, and so must have won 1 game, which scores 3 points.

Question 278: A

To have finished between City and United, Athletic must have got between 23 and 25 points. Hence, they must have got 24 points because no team got the same number of points as another. Athletic won 7 games, which is 21 points, so they must have also got 3 points from drawing 3 games. This accounts for all 10 games they played, so they did not lose any games.

Question 279: C

United won 8 games and drew 1, which is 25 points. Rangers drew 2 games and won none, which is 2 points. Therefore, the difference in points is 23.

Question 280: C

Type 1 departments reached the new target of 95% at least three times since it was introduced. All the other statements are correct.

Question 281: C

Total attendances in Q1 08-9: 5.0 million
Total attendances in Q1 04-5: 4.5 million
The difference = 0.5 million
0.5/5 x 100 = 10% increase

Question 282: C

There are 16 quarters in total since the new target came into effect.
4/16 = 0.25, so the target has been hit 25% of the time i.e. missed 75% of the time.

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Question 283: C

Ranjna must leave Singapore by 20:00 to get to Bali by 22:00. The latest flight she can get is the 19:00. Thus, she must arrive in Singapore by 17:00 (accounting 2 hours for the stopover). The flight from Manchester to Singapore takes 14 hours. Manchester is 8 hours behind Singapore so she must leave Manchester 22 hours before 17:00 on Wednesday, i.e. by 19:00 on Wednesday. Thus, the latest flight she can get is the 18:00 on Wednesday.

Question 284: D

The 08:00 flight will arrive at Singapore for 22:00 on Monday (GMT) or 06:00 Tuesday Singapore time. She then needs a 2-hour stopover, so earliest connecting flight she can get is 08:30 on Tuesday. The flight lands in Bali at 10:30. She then spends 1 hour and 45 minutes getting to her destination – arriving at 12:15 Tuesday.

Question 285: C

A. Incorrect. The graph is about level, and certainly not the steepest gradient post 2007.
B. Incorrect. Although there has been a general decline, there are some blips of increased smoking.
C. Correct.
D. Incorrect. The smoking rate in men decreased from 51% in 1974 to 21% in 2010. Thus, it decreased by more than a half.
E. Incorrect. The percentage difference between men and women smokers has been minimal in the 21st century.

Question 286: D

Look for any duplicated results in the table and if they are present on the graph – Hannah and Alice weigh 68 kg but this can't be found on the graph, so we know that neither option can be weight. You'll also notice that the highest point on the y axis is second on the x axis. This means we need to look at each person with the highest age, IQ and height. The oldest person is Eliza, but she is not second lowest for age or IQ, so age and IQ is not the combination. The tallest person is Rohan, but he is neither the second youngest nor has the second lowest IQ. The person with the highest IQ is Katie, who is also the second shortest, at 151 cm. This means IQ is on the y-axis, and height is on the x-axis, so **D** is correct.

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Question 287: C

This is pretty straightforward; the point is at approximately 172-174 cm in height and 164 -166 cm in arm span. Matthew is the only student who fits these dimensions.

Question 288: C

We are looking for the space within the rectangle and circle, but not in the triangle or square. This leaves only one category with 6 women in it.

Question 289: C

Since we do not know whether they went to university or not, we must add the number of women with children who work and those who went to university, 2, to the number of women with children who work but did not go to university, 1 (2 + 1 = 3).

Question 290: C

To work this out we must add up all the numbers within the rectangle, 4 + 6 + 1 + 2 + 11 + 12 + 7 + 15 = 58

Question 291: E

Here, we are looking at the number of people within the circle and the square. 5 + 2 + 11 = 18.

Question 292: C

To solve this we must work out the total number of people who had children i.e. 3 + 6 + 5 + 11 + 1 + 2 = 28. Then we work out the total number of people who went to university, but that do not also have children so that these are not counted twice: 13 + 12 = 25. Then we add these two numbers together, 28 + 25 = 53 and subtract the number of people who fell into both categories i.e. 53 - (5 + 11 + 2) = 35

Question 293: C

To work this out we must add up all the numbers outside the rectangle that also fall within both the circle and the square, which is 5.

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Question 294: E

This question asks for identification of the blank space, which is the space within the triangle, the rectangle and the square i.e. indicating working women who went to university but did not have children.

Question 295: C

The normal price of these items would be £18.50 (£8 + £7 + £3.50). However, with the 50% discount on meat products, the price in the sale for these items will be £9.25. Thus, Alfred would receive £10.75 of change from a £20 note.

Question 296: C

The number of games played and points scored is a red herring in this question. The important data is 'Goals For' and 'Goals Against'. As this is a defined league and the teams have only played each other, the 'Goals For' column must equal the 'Goals Against' column.

Total Goals For = 16 + 11 + 8 + 7 + 8 + 4 = 54

Total Goals Against = 2 + Wilmslow + 7 + 9 + 12 + 14 = 44 + Wilmslow

For both columns to be equal, Wilmslow must have a total of 54 – 44 = 10 Goals Against.

Question 297: C

Working with the table it is possible to work out that the BMIs of Julie and Lydia must be 21 and 23, and hence their weights 100 and 115 lbs. Thus Emma's weight is 120 lbs, and her BMI must be 22, making her height equivalent to 160 cm.

Question 298: C

You are looking for the fish which is the fifth heaviest and the fifth longest. That is the lobefin, so **C** is the answer.

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Question 299: D

This is a question of estimation. The average production across the year is at least 7 million barrels per day. Multiplying this by 365 gives around 2,550 million barrels per year. All other options require less than 7 million barrels daily production to be produced, apart from **E** which would require significantly more, and it is clear there is at least 7 million barrels per day. Therefore the answer is 2,700 million.

Alternatively we can estimate using 30 days per month and multiply the number of barrels produced per day in each month by 30 (this is more accurate but more time consuming). 6 + 7 + 7 + 7.5 + 7.5 + 7 + 7.5 + 8 + 8.5 + 8.5 + 8 + 9 = 91.5
Multiplying by 30 gives just over 2,700 million barrels.

Question 300: C

Use both graphs. For July, multiply the oil price by the amount sold in the month, and multiply by the number of days in the month.
Thus, July = 7.5 million barrels x $75 per barrel x 31 days = $17,400 million = $17.4 billion

Question 301: A

DNA consists of 4 bases: adenine, guanine, thymine and cytosine. The sugar backbone consists of deoxyribose, hence the name DNA. DNA is found in the cytoplasm of prokaryotes like bacteria.

Question 302: E

Mitochondria are responsible for energy production by ATP synthesis. Animal cells do not have a cell wall, only a cell membrane. The endoplasmic reticulum is important in protein synthesis, as this is where the proteins are assembled.

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Question 303: E

If you aren't studying A-level biology, this question may stretch you. However, it is possible to reach an answer by process of elimination. Mitochondria are the 'powerhouse' of the cell in aerobic respiration, responsible for cell energy production rather than DNA replication or protein synthesis. As energy producers, they are required in muscle cells in large numbers, and in sperm cells to drive the tail responsible for movement. However, though mitochondria provide the energy necessary for a sperm cell to move, they are not the only cause. They are enveloped by a double membrane, possibly because they started out as independent prokaryotes engulfed by eukaryotic cells.

Question 304: A

The majority of bacteria are commensals and don't lead to disease.

Question 305: C

Bacteria carry genetic information on plasmids and not in nuclei like animal cells. They don't need meiosis for replication, as they do not require gametes. Bacterial genomes consist of DNA, just like animal cells.

Question 306: C

Active transport requires a transport protein and ATP, as work is being done against an electrochemical gradient. Unlike diffusion, the relative concentrations of the materials being transported aren't important.

Question 307: D

Meiosis produces haploid gametes. This allows for fusion of 2 gametes to reach a full diploid set of chromosomes again in the zygote.

Question 308: B

Mendelian inheritance separates traits into dominant or recessive. It applies to all sexually reproducing organisms. Don't get confused by statement **3** – the offspring of 2 heterozygotes has a 25% chance of expressing a recessive trait, but it will be homozygous recessive. Remember you cannot express a recessive trait if you are heterozygous for the gene, so the question is not concerned with carriers.

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Question 309: A

Hormones are released into the bloodstream and act on receptors in different organs in order to cause relatively slow changes to the body's physiology. Hormones frequently interact with the nervous system, e.g. adrenaline and insulin, however, they don't directly cause muscles to contract. Almost all hormones are synthesised.

Question 310: D

Neuronal signalling can happen via direct electrical stimulation of nerves or via chemical stimulation of synapses which produces a current that travels along the nerves. Electrical synapses are very rare in mammals, the majority of mammalian synapses are chemical.

Question 311: D

Remember that pH changes cause changes in electrical charge on proteins (= polypeptides) that could interfere with protein – protein interactions. Whilst the other statements are all correct to a certain extent, they are the downstream effects of what would happen if enzymes (which are also proteins) didn't work.

Question 312: A

The bacterial cell wall is made up of murein and protects the bacterium from the external environment, in particular from osmotic stresses, and is important in most bacteria.

Question 313: C

Sexual reproduction relies on formation of gametes during **meiosis**. Mitosis doesn't produce genetically distinct cells. Mitosis is, however, the basis for tissue growth.

Question 314: A

A mutation is a permanent change in the nucleotide sequence of DNA. Whilst mutations may lead to changes in organelles and chromosomes, or even be harmful, they are strictly defined as permanent changes to the DNA or RNA sequence. Mutations do not necessarily cause cancer, even though it is possible.

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Question 315: E

Mutations are fairly common, but in the vast majority of cases do not have any impact on phenotype due to the redundancy of the genome. Sometimes they can confer selective advantages and allow organisms to survive better (i.e. evolve by natural selection), or they can lead to cancers as cells start dividing uncontrollably.

Question 316: D

Antibodies represent a pivotal molecule of the immune system. They provide very pointed and selective targeting of pathogens and toxins without causing damage to the body's own cells.

Question 317: A

Kidneys are not involved in digestion but do filter the blood of waste products. Glucose is found in high concentrations in the urine of diabetics, but not in healthy people.

Question 318: D

Hormones are slower acting than nerves and act for a longer time. Hormones also act in a more general way. Adrenaline is also a hormone released into the body causing the fight-or-flight response. Although it is quick acting, it still lasts for a longer time than a nervous response, as you can still feel its effects for a time after the response, e.g. shaking hands.

Question 319: D

Homeostasis is about minimising changes to the internal environment by modulating both input and output.

Question 320: B

There is less energy and biomass each time you move up a trophic level. Only 10% of consumed energy is transferred to the next trophic level, so only one tenth of the previous biomass can be sustained in the next trophic level up.

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Question 321: A

In asexual reproduction, there is no fusion of gametes as the single parent cell divides. There is therefore no mixing of chromosomes and, as a result, no genetic variation.

Question 322: E

The image is first formed on the retina which conveys it to the brain via a sensory nerve. The brain then sends an impulse to the muscle via a motor neuron.

Question 323: D

Blood from the kidney returns to the heart via the renal (kidney-related) vein, which drains into the inferior vena cava. The blood then passes through the pulmonary vasculature (veins carry blood to the heart, arteries away from the heart) before going into the aorta and eventually the hepatic (liver-related) artery.

Question 324: E

Clones are genetically identical by definition, and a large number of them could conceivably reduce the gene pool of a population. In adult cell cloning, the genetic material of an egg is replaced with the genetic material of an adult cell. Cloning is possible for all DNA based life forms, including plants and other types of animals.

Question 325: E

Gene varieties cause intraspecies variation, e.g. different eye colours. If mutations confer a selective advantage, those individuals with the mutation will survive to reproduce and grow in numbers. Genetic variation is caused by mixing of parent genomes and mutations. Species with similar characteristics often do have similar genes.

Question 326: E

Alleles are different versions of the same gene. If you are a homozygous for a trait, you have two identical alleles for that particular gene, and if you are heterozygous you have two different alleles of that gene. Recessive traits only appear in the phenotype when there are no dominant alleles for that trait, i.e. two recessive alleles are carried.

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Question 327: D

Remember that red blood cells don't have a nucleus and therefore have no DNA. In meiosis, a diploid cell divides in such a way so as to produce four haploid cells. Any type of cell division will require energy.

Question 328: C

The hypothalamus detects too little water in the blood, so the pituitary gland releases ADH. The kidney maintains the blood water level and allows less water to be lost in the urine until the blood water level returns to normal.

Question 329: E

Venous blood has a higher level of carbon dioxide and lower oxygen. Carbon dioxide forms carbonic acid in aqueous solution, thus making the pH of venous blood slightly more acidic than arterial blood. This leaves only **E** as a possibility.

Question 330: E

The cytoplasm is 80% water, but also contains, among other things, electrolytes and proteins. The cytoplasm doesn't contain everything, e.g. DNA is found in the nucleus.

Question 331: C

ATP is produced by mitochondria in aerobic respiration and in the cytoplasm during anaerobic respiration only.

Question 332: C

The cell membrane allows both active transport and passive transport by diffusion of certain ions and molecule and is found in eukaryotes and prokaryotes like bacteria. It is a phospholipid bilayer.

Question 333: A

1 and 2 only: 223 PAIRS = 446 chromosomes; meiosis produces 4 daughter cells with half of the original number of chromosomes each, while mitosis produces two daughter cells with the original number of chromosomes each.

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Question 334: E

If Bob is homozygous dominant (RR) the probability of having a child with red hair is 0%. However, if Bob is heterozygous (Rr), there is a 50% chance of having a child with red hair, since Mary must be homozygous recessive (rr) to have red hair. As we do not know Bob's genotype, both possibilities must be considered.

Question 335: A

If an offspring is born with red hair, it confirms Bob is heterozygous (Rr). He cannot have a red-haired child if he is homozygous dominant (RR) and would himself have red hair were he homozygous recessive (rr).

Question 336: A

A cross between rr and Rr results in 50% Rr and 50% rr offspring. 50% of offspring will have black hair, but they will be heterozygous for the red hair allele.

Question 337: C

When the chest walls expand, the intra-thoracic pressure decreases. This causes the atmospheric pressure outside the chest to be greater than pressure inside the chest, resulting in a flow of air into the chest.

Question 338: A

Producers are found at the bottom of food chains and always have the largest biomass.

Question 339: E

All the statements are true; the carbon and nitrogen cycles are examinable in Section 2, so make sure you understand them! The atmosphere is 79% inert N_2 gas, which must be 'fixed' to useable forms by high-energy lightning strikes or by bacterial mediation. Humans also manually fix nitrogen for fertilisers with the Haber process.

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Question 340: E

None of the above statements are correct. Mutations can be silent, cause a loss of function, or even a gain in function, depending on the exact location in the gene and the base affected. Mutations only cause a change in protein structure if the amino acids expressed by the gene affected are changed. This is normally due to a shift in reading frame. Whilst cancer arises as a result of a series of mutations, very few mutations actually lead to cancer.

Question 341: C

All of these are functions of the CNS except for **C**, as sensing painful stimuli is a function of the receptors and nerves of the peripheral nervous system.

Question 342: E

None of the above are correct. There is no voluntary input to the heart in the form of a neuronal connection. Parasympathetic neurones slow the heart and sympathetic nervous input accelerates the heart rate.

Question 343: B

If lipase is not working, fat from the diet will not be broken down, and will build up in the stool.

Question 344: E

Oxygenated blood flows from the lungs to the heart via the pulmonary vein. The pulmonary artery carries deoxygenated blood from the heart to the lungs. Animals like fish have single circulatory systems. Deoxygenated blood is found in the superior vena cava, returning to the heart from the body. Veins in the arms and hands frequently don't have valves.

Question 345: E

Enzymatic digestion takes place throughout the GI tract, including in the mouth (e.g. amylase), stomach (e.g. pepsin), and small intestine (e.g. trypsin). The large intestine is primarily responsible for water absorption, whilst the rectum acts as a temporary store for faecal matter. Digestion has finished by the rectum, and so it has the least amount of enzymatic digestion occurring.

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Question 346: B

This is an example of the monosynaptic stretch reflex; these reflexes are performed at the spinal level and therefore don't involve the brain.

Question 347: A

Statement **2** describes diffusion, as CO_2 is moving with the concentration gradient. Statement **3** describes active transport, as amino acids are moving against the concentration gradient.

Question 348: E

3 is the correct equation for animals, and **4** is correct for plants.

Question 349: C

The mitochondria are only the site for aerobic respiration, as anaerobic respiration occurs in the cytoplasm. Aerobic respiration produces more ATP per substrate than anaerobic respiration, and therefore is more efficient.

The chemical equation for glucose being respired aerobically is: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$.

Thus, the molar ratio is 1:6 (i.e. each mole of glucose produces 6 moles of CO_2).

Question 350: B

The nucleus contains the DNA and chromosomes of the cell. The cytoplasm contains enzymes, salts and amino acids in addition to water. The plasma membrane is a bilayer. Lastly, the cell wall is indeed responsible for protecting vs. increased osmotic pressures.

Question 351: D

When a medium is hypertonic relative to the cell cytoplasm, it is more concentrated than the cytoplasm, and when it is hypotonic, it is less concentrated. So, when a medium is hypotonic relative to the cell cytoplasm, the cell will gain water through osmosis. When the medium is isotonic, there will be no net movement of water across the cell membrane. Lastly, when the medium is hypertonic relative to the cell cytoplasm, the cell will lose water by osmosis.

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Question 352: A

Stem cells have the ability to differentiate and produce other kinds of cells. However, they also have the ability to generate cells of their own kind and stem cells are able to maintain their undifferentiated state. The two types of stem cells are embryonic stem cells and adult stem cells. The adult stem cells are present in both children and adults.

Question 353: B

All of the following statements are examples of natural selection, except for the breeding of horses. Breeding and animal husbandry are notable methods of artificial selection, which are brought about by humans.

Question 354: C

Enzymes create a stable environment to stabilise the transition state. Enzymes do not distort substrates. Enzymes generally have little effect on temperature directly. Lastly, they are able to provide alternative pathways for reactions to occur.

Question 355: C

A negative feedback system seeks to minimise changes in a system by modulating the response in accordance with the error that's generated. Salivating before a meal is an example of a feed-forward system (i.e. salivating is an anticipatory response). Throwing a dart does not involve any feedback (during the action). pH and blood pressure are both important homeostatic variables that are controlled via powerful negative feedback mechanisms, e.g. massive haemorrhage leads to compensatory tachycardia.

Question 356: A

One of the major functions of white blood cells is to defend the body against bacterial and fungal infections. They can kill pathogens by engulfing them and also use antibodies to help them recognise pathogens. Antibodies are produced by white blood cells.

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Question 357: B

The cardiovascular system does indeed transport nutrients and hormones. It also increases blood flow to exercising muscles (via differential vasodilatation) and also helps with thermoregulation (e.g. vasoconstriction in response to cold). The respiratory system is responsible for oxygenating blood.

Question 358: C

Adrenaline always increases heart rate and is almost always released during sympathetic responses. It travels primarily in the blood and affects multiple organ systems. It is also a potent vasoconstrictor.

Question 359: B

Protein synthesis occurs in the cytoplasm. Proteins are usually coded by several amino acids. Red blood cells lack a nucleus and, therefore, the DNA to create new proteins. Protein synthesis is a key part of mitosis, as it allows the parent cell to grow prior to division.

Question 360: E

Remember that most enzymes work better in neutral environments (amylase works even better at slightly alkaline pH). Thus, adding sodium bicarbonate will increase the pH and hence increase the rate of activity. Adding carbohydrate will have no effect, as the enzyme is already saturated. Adding amylase will increase the amount of carbohydrate that can be converted per unit time. Increasing the temperature to 100◦ C will denature the enzyme and reduce the rate.

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Question 361: E

Taking the normal allele to be C and the diseased allele to be c, one can model the scenario with the following Punnett square:

		Carrier Mother	
		C	**c**
Diseased Father	**c**	Cc	cc
	c	Cc	cc

The gender of the children is irrelevant as the inheritance is autosomal recessive, but we see that all children produced would inherit at least one diseased allele.

Question 362: E

All of the organs listed have endocrine functions. The thyroid produces thyroid hormone. The ovary produces oestrogen. The pancreas secretes glucagon and insulin. The adrenal gland secretes adrenaline. The testes produce testosterone.

Question 363: A

Insulin works to decrease blood glucose levels. Glucagon causes blood glucose levels to increase; glycogen is a carbohydrate. Adrenaline works to increase heart rate.

Question 364: A

The left side of the heart contains oxygenated blood from the lungs which will be pumped to the body. The right side of the heart contains deoxygenated blood from the body to be pumped to the lungs.

Question 365: A

Since Individual 1 is homozygous normal, and individual 5 is heterozygous and affected, the disease must be dominant. Since males only have one X-chromosome, they cannot be carriers for X-linked conditions. If Nafram syndrome was mitochondrial, the disease could not be passed on by males, and as 2 is the affected one of the couple none of their children would have the disease.

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Question 366: C

We know that the inheritance of Nafram syndrome is autosomal dominant, so using N to mean a diseased allele and n to mean a normal allele, 5, 7 and 8 must be Nn because they have an unaffected parent. 2 is also Nn, as if she was NN, all her children would be Nn and so affected by the disease, which is not the case, as 3 and 4 are unaffected.

Question 367: A

Since 6 is disease free, his genotype must be nn. Thus, neither of 6's parents could be NN, as otherwise 6 would have at least one diseased allele.

Question 368: A

Urine passes from the kidney into the ureter and is then stored in the bladder. It is finally released through the urethra.

Question 369: E

Deoxygenated blood from the body flows through the inferior vena cava to the right atrium, where it flows to the right ventricle to be pumped via the pulmonary artery to the lungs where it is oxygenated. It then returns to the heart via the pulmonary vein into the left atrium, then into the left ventricle where it is pumped to the body via the aorta.

Question 370: E

During inspiration, the pressure in the lungs decreases as the diaphragm contracts, increasing the volume of the lungs. The intercostal muscles contract in inspiration, lifting the rib cage.

Question 371: D

Whilst **A**, **B**, **C** and **E** are true of the DNA code, they do not represent the property described, which is that more than one combination of codons can encode the same amino acid, e.g. serine is coded by the sequences: TCT, TCC, TCA, TCG.

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Question 372: B

The degenerate nature of the code can help to reduce the deleterious effects of point mutations. The several 3-nucleotide combinations that code for each amino acid are usually similar, so that a point mutation, i.e. a substitution of one nucleotide for another, can still result in the same amino acid as the one coded for by the original sequence.

The degenerate nature of the code does little to protect against deletions/insertions/duplications, which will cause the bases to be read in incorrect triplets, i.e. result in a frame shift.

Question 373: D

The hypothalamus is the site of central thermoreceptors. A decrease in environmental temperature decreases sweat secretion and causes cutaneous vasoconstriction to minimise heat loss from the blood.

Question 374: A

The movement of carbon dioxide in the lungs and neurotransmitters in a synapse are both examples of diffusion. Glucose reabsorption is an active process, as it requires work to be done against a concentration gradient.

Question 375: E

Some enzymes contain other molecules besides protein, e.g. metal ions. Enzymes can increase rates of reaction that may result in heat gain/loss, depending on if the reaction is exothermic or endothermic. They are prone to variations in pH and are highly specific to their individual substrate.

Question 376: A

Prokaryotic cells contain 70S ribosomes, which are smaller in size than 80S eukaryotic ribosomes. Eukaryotic cells are generally 10X larger than prokaryotic cells. Amino acids and ATP form the basis of all cellular life and are the same size in both.

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Question 377: D

Statements **1** and **3** are facts; hydrogen ions displace oxygen bound to iron-containing haemoglobin, forming haemoglobinic acid. Statement **2** is the opposite of the truth as increased acidity **decreases,** rather than increases, haemoglobin's affinity for oxygen.

Question 378: E

- Row 1: simple diffusion & osmosis
- **Row 2: active transport & facilitated diffusion**
- Row 3: osmosis & active transport
- Row 4: active transport & simple diffusion
- Row 5: vesicular transport & active transport

Question 379: A

In the absence of oxygen, the Krebs cycle and electron transport chain (including oxidative phosphorylation) cannot occur in the mitochondria. Pyruvate is not converted into acetyl-CoA as in aerobic conditions but is instead reversibly converted into lactate in animals or irreversibly converted into ethanol in plants and yeast through the fermentation process. ATP is still generated in low yields through glycolysis occurring in the cytoplasm.

Question 380: A

Primary protein structures represent the basic amino acid sequence. Therefore, the only bonds present are peptide bonds between the amino acids. Secondary protein structures contain hydrogen bonds in addition to peptide bonds; these hydrogen bonds allow alpha-helices and beta-sheets structures to form. Disulfide bonds and hydrophobic bonds, as well as ionic bonds, are features of tertiary (and quaternary) protein structure.

Question 381: C

There are many groups of enzymes, but the dehydrogenases are the enzymes which take part in oxidation reactions. Many dehydrogenases will have been studied throughout the syllabus, especially during steps of glycolysis.

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Question 382: B

Cholesterol, phospholipid, glycolipids and glycoproteins are all components of a typical phospholipid bilayer plasma membrane. Nucleic acids are not.

Question 383: A

A standard protocol would involve isolating mRNA, reverse transcribing the mRNA into cDNA, tagging the cDNA with fluorescent tags before hybridising this onto probes of a microarray plate. The plate is scanned and the amount of fluorescence per well will determine how much a gene is being expressed.

Question 384: A

A simple Punnett square here would reveal that there is a 50% chance of the parents having a child with colour-blindness (one female and one male).

	X^c	Y
X^c	**X^cX^c**	**X^cY**
X^+	X^+X^c	X^+Y

Question 385: C

All are true about evolution and selection, but for option **C** the opposite is true. Disruptive selection refers to those with extreme phenotypes being more likely to survive than the intermediate phenotype.

Question 386: E

- Statement **1** is incorrect as you cannot be an unaffected carrier of an autosomal dominant condition
- Statement **2** is incorrect as women can be affected by X-linked recessive conditions; it is just rarer than men being affected.
- Statements **3** and **4** are correct.

Question 387: D

Meiosis occurs in the testes in males during puberty. Chiasmata formation and crossing over occurs during prophase I in a process called independent assortment. The first, not the second, meiotic division generates the haploid cells (2n to n), whilst the second meiotic division is more similar to a mitotic process.

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Question 388: C

The only true statement is the fact that a synapse can exist between a neuron and a non-neuron cell, such as a muscle or gland. There are excitatory neurotransmitters in addition to inhibitory neurotransmitters and myelination is a very important factor for signal transmission speeds. Signals can only be unidirectional and sodium ions move into neurons, creating the change in charge seen with depolarisation.

Question 389: A

Light energy results in the excitation of electrons in the **chlorophyll** and electrons are passed along a series of electron acceptors in the **thylakoid** membrane. This leads to the production of ATP and **$NAPDH_2$** which then drive the light-independent reaction in the **stroma**.

Question 390: D

Eukaryotic DNA is contained within a membrane, whereas prokaryotic DNA does not contain intronic sequences, but does contain operons and resides in the cytoplasm. Eukaryotic DNA is packaged into chromosome structures, but prokaryotes do also contain one chromosome structure (circular DNA).

Question 391: E

Carbon monoxide reduces the oxygen-binding capacity of blood, rather than tar. However, tar is known to cause the other damaging effects listed.

Question 392: D

After an action potential, the neurotransmitter release causes depolarisation of the sarcolemma and calcium ions bind to troponin. This allows the release of tropomyosin, subsequently altering its positioning to expose actin active sites which can then be bound by myosin. Myosin rotates to pull the filaments towards the centre of the sarcomere. The energy released during ATP hydrolysis changes the angle of myosin head, and it is now in position for further movement (power stroke).

Question 393: C

FSH and LH are the only hormones listed to be secreted from the pituitary gland – progesterone and oestrogen are secreted from the ovaries. LH targets the ovaries to stimulate ovulation and the release of an egg.

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Question 394: B

The only positive result from these biochemical tests is the Biuret test, showing a purple (violet) colour. This would indicate that a protein is present. The only protein listed is amylase which, whilst an enzyme, is also a protein.

Question 395: E

Maintenance of blood glucose levels, the regulation of water concentration by ADH and the maintenance of body temperature are classic examples of negative feedback mechanisms. Generation of an action potential, whilst a feedback mechanism, is thought of as positive feedback.

Question 396: A

Phagocytosis is carried out by macrophages and neutrophils. T-cells (or T-lymphocytes) bind directly to the foreign antigen, mature in the thymus gland and T-helper cells can secrete cytokines. B-cells, or B-lymphocytes, mature in the bone marrow, can develop into plasma cells, which can secrete antibodies.

Question 397: B

Meiosis is responsible for the production of gametes in reproduction and produces genetically non-identical cells, therefore this is not a function of mitosis. The rest of the answers are ways in which our bodies use mitosis to grow and repair.

Question 398: C

Secreted proteins are made on ribosomes found in the rough endoplasmic reticulum. Transport vesicles can move proteins from the RER to the Golgi apparatus. Secretory vesicles bud off from the Golgi, ready to release insulin through merging with the plasma membrane.

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Question 399: A

The given sequence is a snippet of single-stranded RNA sequence from the HIV virus. Two DNA strands will form from the given sequence – the complementary DNA strand, and then the second strand of the DNA. In DNA, uracil is substituted for thymine. Both uracil and thymine form a complementary base pair with adenine. This means to calculate the total number of thymine nucleotides in the double-stranded DNA, simply count how many times uracil or adenine appears in the initial sequence – 7.

Question 400: A

Valves are found only in veins and not in arteries or capillaries. Elastic fibres are found in arteries and veins. Sphincter muscles are found in arterioles to funnel blood from larger vessels to smaller vessels, such as arteries into capillaries.

Question 401: D

Different isotopes are differentiated by the number of neutrons in the core. This gives them different molecular weights and different chemical properties with regards to stability. The number of protons defines each element, and the number of electrons its charge.

Question 402: E

A displacement reaction occurs when a more reactive element displaces a less reactive element in its compound. Reactions **1**, **2** and **3** are examples of displacement reactions as a less reactive element is being replaced by a more reactive one. Reaction **4** is an example of a neutralisation reaction.

Question 403: A

We know that there must be three Ca on the left, so a=3. This means the answer is **A** or **C**. Next, notice that we need to make sure there are two P on the left, so b = 2. This doesn't give us our answer but allows us to check we're on the right path. Finally, with our a and b values, we can calculate there are 14 moles of O on the left, so c must be 6 in order to balance the equation.

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Question 404: A

First, look at Ag. There are 9 on the right and 1 on the left, so s = 9. This rules out **B** and **E**. Next, look at P. t must be 3 if the moles of P are to be balanced. This leaves us with options **A** and **C**. Finally, you can see that there are 9 moles of K of the left, so u = 9, so **A** is the answer.

Question 405: D

A more reactive halogen can displace a less reactive halogen. Thus, chlorine can displace bromine and iodine from an aqueous solution of its salts, and fluorine can replace chlorine. The trend is the opposite for alkali metals, where reactivity increases down the group as electrons are further from the core and easier to lose.

Question 406: C

$2Mg + O_2 = 2MgO$

so, 2 x 24 = 48 and 2 x (24 + 16) = 80

so, 48 g of magnesium produces 80g of magnesium oxide

so 1g of magnesium produces 1g x 80g/48g = 1.666g oxide

so 75g x 1.666 = 125g

Question 407: B

$H_2 + 2OH^- \rightarrow 2H_2O + e^-$

Hydrogen loses electrons, so it is oxidised.

Question 408: E

Ammonia is 1 nitrogen and 3 hydrogen atoms bonded covalently. N = 14g and H = 1g per mole, so percentage of N in NH_3 = 14g/17g = 82%. It can be produced from N_2 through fixation or the industrial Haber process for use in fertiliser and may break down to its components.

Question 409: A

Milk is weakly acidic, pH 6.5-7.0, and contains fat. This is broken down by lipase to form fatty acids - turning the solution slightly more acidic.

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Question 410: C

Glucose loses four hydrogen atoms – one definition of an oxidation reaction is a reaction in which there is loss of hydrogen.

Question 411: C

Isotopes have the same number of protons and electrons, but a different number of neutrons. The number of neutrons has no impact on the rate of reactions.

Question 412: E

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$

Number of moles of Mg = $\frac{6}{24}$ = 0.25 moles.

1 mole of Mg reacts with 1 mole H_2SO_4 to produce 1 mole of magnesium sulfate. Therefore, 0.25 moles H_2SO_4 will react to produce 0.25 moles of $MgSO_4$.

M_r of H_2SO_4 = 2 + 32 + 64 = 98g per mole

The mass of H_2SO_4 used = 0.25 moles x 98g per mole = 24.5g.

Since 30g of H_2SO_4 is present, H_2SO_4 is in excess, and the magnesium is the limiting reagent.

M_r of $MgSO_4$ = 24 + 32 + 64 = 120g per mole

The mass of $MgSO_4$ produced = 0.25 moles x 120g per mole = 30g which is the same mass as that of sulfuric acid in the original reaction.

Question 413: E

Reactivity series of metals:

Cu is more reactive than Ag and will displace it.

Ca is more reactive than H and will displace it.

2 and **4** are incorrect because Fe is higher in the reactivity series than Cu and Fe is lower in the reactivity series than Ca, so no displacement will occur.

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Question 414: E

Moving left to right is the equivalent of moving down the metal reactivity series (i.e. Na is most reactive, and Zn is least reactive). Therefore, moving from left to right, the reactivity of the metals decreases, likelihood of corrosion decreases, less energy is required to separate metals from their ores and metals lose electrons less readily to form positive ions.

Question 415: D

Halogens become less reactive as you progress down group 17. Thus in order of increasing reactivity from left to right: I→ Br→ Cl. Therefore, I will not displace Br, Cl will displace Br and Br will displace I.

Question 416: A

Wires are made out of copper because it is a good conductor of electricity. Copper is also used in coins (not aluminium). Aluminium is resistant to corrosion because of a layer of aluminium oxide (not hydroxide).

Question 417: C

$2Li + 2H_2O \rightarrow 2LiOH + H_2$

Therefore, 2 moles of Li react to produce 1 mole of H_2 gas (24 dm^3).

The number of moles of Li = $\frac{21}{7}$ = 3 moles.

Thus, 1.5 moles of H_2 gas are produced = 36 dm^3.

Question 418: B

$MgCl_2$ contains stronger bonds than NaCl because Mg ions have a 2+ charge, thus having a stronger electrostatic pull for negative chloride ions. The smaller atomic radius also means that the nucleus has less distance between it and incoming electrons. Transition metals are able to form multiple stable ions e.g. Fe^{2+} and Fe^{3+}.

Covalently bonded structures do tend to have lower melting points than ionically bonded structures, but the giant covalent structures (diamond and graphite for example) have very high melting points.

Graphite is an example of a covalently bonded structure which conducts electricity.

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Question 419: D

Energy is released from reaction **A**, as shown by a negative enthalpy. The reaction is therefore exothermic. Since energy is released, the product CO_2 has less energy than the reactants did. Therefore, CO_2 is more stable. Reaction **B** has a positive enthalpy, which means energy must be put into the reaction for it to occur i.e. it's an endothermic reaction. That means that the products (CaO and CO_2) have more energy and are less stable than the reactants ($CaCO_3$).

Question 420: B

Solid oxides are unable to conduct electricity because the ions are immobile. Metals are extracted from their molten ores by electrolysis. Fractional distillation is used to separate miscible liquids with similar boiling points. Mg^{2+} ions have a greater positive charge and a smaller ionic radius than Na^+ ions, and therefore form stronger bonds.

Question 421: E

Li^+ (2) and Na^+ (2, 8)
Mg^{2+} (2, 8) and Ne (2, 8)
Na^{2+} (2, 7) and Ne (2, 8)
O^{2+} (2, 4) and a Carbon atom (2, 4)

Question 422: B

Reactivity of both Group 1 and 2 increases as you go down the groups because the valence electrons that react are further away from the positively charged nucleus (which means the electrostatic attraction between them is weaker). Group 1 metals are usually more reactive because they only need to donate one electron, whilst Group 2 metals must donate two electrons.

Question 423: D

This is a straightforward question that tests basic understanding of kinetics. Catalysts help overcome energy barriers by reducing the activation energy necessary for a reaction to take place.

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Question 424: D

H^1 contains 1 proton and no neutrons. Isotopes have the same numbers of protons, but different numbers of neutrons. Thus, H^3 contains two more neutrons than H^1.

Question 425: D

Oxidation is the loss of electrons and reduction is the gain of electrons (therefore increasing electron density). Halogens tend to act as electron recipients in reactions and are therefore good oxidising agents.

Question 426: D

These statements all come from the Kinetic Theory of Gases, an idealised model of gases that allows for the derivation of the ideal gas law. The angle at which gas molecules move is not related to temperature; movement is random. Gas molecules lose no energy when they collide with each other, collisions are assumed elastic. The average kinetic energy of gas molecules is the same for all gases at the same temperature as they are assumed to be point masses. Momentum = mass x velocity. Therefore, the momentum of gas molecules increases with pressure as a greater force is exerted on each molecule.

Question 427: E

An exothermic reaction is defined as a chemical reaction that releases energy. Thus, aerobic respiration producing energy in the form of ATP, the burning of magnesium, and the reacting of acids and bases are almost always exothermic processes. Similarly, the combustion of most things (including hydrogen) is exothermic. Evaporation of water is a physical process in which no chemical reaction is taking place.

Question 428: E

$2\ C_3H_6 + 9\ O_2 \rightarrow 6\ H_2O + 6\ CO_2$

Assign the oxidation numbers for each element:

For C_3H_6: C = -2; H = +1

For O_2: O = 0

For H_2O: H = +1; O = -2

For CO_2: C = +4; O = -2

Look for the changes in the oxidation numbers:

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H remained at +1
C changed from -2 to +4. Thus, it was oxidized
O changed from 0 to -2. Thus, it was reduced.

Question 429: B

The equation for the reaction is: $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
Assign oxidation numbers for each element:
For Zn: Zn = 0
For $CuSO_4$: Cu = +2; S = +6; O = -2
For $ZnSO_4$: Zn = +2; S = +6; O = -2
For Cu: Cu = 0
With these oxidation numbers, we can see that Zn was oxidized and Cu in $CuSO_4$ was reduced. Thus, Zn acted as the reducing agent and Cu in $CuSO_4$ is the oxidizing agent.

Question 430: B

Acids are proton donors, not proton acceptors. Strong acids are fully ionised – it is weak acids which only partially ionise in a solution. Weak acids have a pH of less than 7. The reaction between an acid and a base produces water and a salt. Strong acids will turn universal indicator solution red or orange.

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Question 431: E

Let x be the relative abundance of Z^6 and y the relative abundance of Z^8.

The average atomic mass takes the abundances of all 3 isotopes into account.

Thus, (Abundance of Z^5) (Mass Z^5) + (Abundance of Z^6) (Mass Z^6) + (Abundance of Z^8) (Mass Z^8) = 7

Therefore: (5 x 0.2) + 6x + 8y = 7

So: 6x + 8y = 6

Divide by two to give: 3x + 4y = 3

The abundances of all isotopes = 100% = 1

This gives: 0.2 + x + y = 1

Solve the two equations simultaneously:

y = 0.8 – x

3x + 4(0.8 – x) = 3

3x + 3.2 – 4x = 3

Therefore, x = 0.2

y = 0.8 - 0.2 = 0.6

Thus, the overall abundances are Z^5 = 20%, Z^6 = 20% and Z^8 = 60%. Therefore, all the statements are correct.

Question 432: A

If a metal is more reactive than hydrogen, a displacement reaction will occur resulting in the formation of a salt with the metal cation and hydrogen.

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Question 433: B

$6\ FeSO_4 + K_2Cr_2O_7 + 7\ H_2SO_4 \rightarrow 3\ (Fe)_2(SO_4)_3 + Cr_2(SO_4)_3 + K_2SO_4 + 7\ H_2O$

In order to save time, you have to quickly eliminate options (rather than try every combination out).

The quickest way is to do this is algebraically:

For Potassium:

$2b = 2e = 2f$

Therefore, b = f.

Option F does not fulfil b = e = f.

For Iron:

$a = 2d$

Options **C**, **D** and **E** don't fulfil a = 2d.

For Hydrogen:

$2c = 2g$

Therefore, c = g.

Option **A** does not fulfil c = g.

This leaves option **B** as the answer.

Question 434: E

Atoms have a neutral charge. Ions have different numbers of electrons when compared to atoms of the same element. Protons provide just under 50% of an atom's mass; the other 50% is provided by neutrons. Isotopes don't exhibit significantly different kinetics. Protons do indeed repel each other in the nucleus (which is one reason why neutrons are needed: to reduce the electrical charge density).

Question 435: B

The noble gases are extremely useful, e.g. helium in blimps, neon signs, argon in bulbs. They are colourless and odourless and have no valence electrons. As with the rest of the periodic table, boiling point increases as you progress down the group (because of increased Van der Waals forces). Helium is the most abundant noble gas (and indeed the 2nd most abundant element in the universe).

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Question 436: D

Alkenes can be hydrogenated (i.e. reduced) to alkanes. Aromatic compounds are commonly written as cyclic alkenes, but their properties differ from those of alkenes. Therefore alkenes and aromatic compounds do not belong to the same chemical class.

Question 437: A

The average atomic mass takes the abundances of both isotopes into account:

(Abundance of Cl^{35}) (Mass Cl^{35}) + (Abundance of Cl^{37}) (Mass Cl^{37}) = 35.453

34.969 (Abundance of Cl^{35}) + 36.966 (Abundance of Cl^{37}) = 35.453

The abundances of both isotopes = 100% = 1

I.e. abundance of Cl^{35} + abundance of Cl^{37} = 1

Therefore: $x + y = 1$ which can be rearranged to give: $y = 1-x$

Therefore: $x + (1 - x) = 1$.

$34.969x + 36.966(1-x) = 35.453$

$x = 0.758$

$1 - x = 0.242$

Therefore, Cl^{35} is 3 times more abundant than Cl^{37}.

Note that you could approximate the values here to arrive at the solution even quicker, e.g. 34.969 → 35, 36.966 → 37 and 35.453 → 35.5

Question 438: A

Transition metals form multiple stable ions which may have many different colours (e.g. green Fe^{2+} and brown Fe^{3+}). They usually form ionic bonds and are commonly used as catalysts (e.g. iron in the Haber process, Nickel in alkene hydrogenation). They are excellent conductors of electricity and are known as the d-block elements.

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Question 439: B

$2Na + 2H_2O \rightarrow 2NaOH + H_2$

8000 cm^3 = 8 dm^3 = ⅓ moles of H_2

2 moles of Na react completely to form 1 mole of H_2.

Therefore, ⅔ moles of Na must have reacted to produce ⅓ moles of Hydrogen. ⅔ x 23g per mole = 15.3g.

% Purity of sample = $\frac{15.3}{20}$ x 100 = 76.5%

Question 440: C

Assume total mass of molecule is 100g. Therefore, it contains 70.6g carbon, 5.9g hydrogen and 23.5g oxygen. Now, calculate the number of moles of each element using Moles = $\frac{\text{Mass}}{\text{Molar Mass}}$

Moles of Carbon = $\frac{70.6}{12} \approx 6$

Moles of Hydrogen = $\frac{5.9}{1} \approx 6$

Moles of Oxygen = $\frac{23.5}{16} \approx 1.5$

Therefore, the molar ratios give an empirical formula of $C_6H_6O_{1.5} = C_4H_4O$.

Molar mass of the empirical formula = (4 x 12) + (4 x 1) + 16 = 68.

Molar mass of chemical formula = 136.

Therefore, the chemical formula = $C_8H_8O_2$.

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Question 441: B

$S + 6\ HNO_3 \rightarrow H_2SO_4 + 6\ NO_2 + 2\ H_2O$

In order to save time, you have to quickly eliminate options (rather than try every combination out).

The quickest way to do this is algebraically:

For Hydrogen:

$b = 2c + 2e$

Options **A**, **C**, **D**, and **E** don't fulfil $b = 2c + 2e$.

This leaves option **B** as the only possible answer.

Note how quickly we were able to get the correct answer here by choosing an element that appears in 3 molecules (as opposed to Sulphur or Nitrogen which only appear in 2).

Question 442: A

Alkenes undergo addition reactions, such as with hydrogen with a nickel catalyst, whilst alkanes do not as they are already fully saturated. The C=C bond is stronger than the C-C bond, but it is not exactly twice as strong, so will not require twice the energy to break it. Both molecules are organic and will dissolve in organic solvents.

Question 443: D

Diamond is unable to conduct electricity because all the electrons are involved in covalent bonds. Graphite is insoluble in water + organic solvents. Graphite is also able to conduct electricity because there are free electrons that are not involved in covalent bonds.

Methane and Ammonia both have low melting points. Methane is not a polar molecule, so cannot conduct electricity or dissolve in water. Ammonia is polar and will dissolve in water. It can conduct electricity in aqueous form, but not as a gas.

Question 444: A

Catalysts increase the rate of reaction by providing an alternative reaction path with a lower activation energy, which means that less energy is required and so costs are reduced. The point of equilibrium, the nature of the products, and the overall energy change are unaffected by catalysts.

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Question 445: E

The 5 carbon atoms in this hydrocarbon make it a "pent" stem. The C=C bond makes it an alkene, and the location of this bond is the 2nd position, making the molecule pent-2-ene.

Question 446: D

Group 1 elements form positively charged ions in most reactions and therefore lose electrons. Thus, the oxidation number must increase. Their reactivity increases down the group as the valence electrons are further away from the positively charged nucleus. All Group 1 elements react spontaneously with oxygen – the less reactive ones form an oxide coating and the more reactive ones spontaneously burn.

Question 447: E

The cathode attracts positively charged ions. The cathode reduces ions and the anode oxidises ions. Electrolysis can be used to separate compounds but not mixtures (i.e. substances that are not chemically joined).

Question 448: C

Pentane, C_5H_{12}, has a total of 3 isomers. **A**, **C** and **D** are correctly configured. However, the 4th Carbon atom in option **B** has more than 4 bonds which wouldn't be possible. If you're stuck on this – draw them out!

Question 449: E

$3\ Cu + 8\ HNO_3 \rightarrow 3\ Cu(NO_3)_2 + 2\ NO + 4\ H_2O$

In order to save time, you have to quickly eliminate options (rather than try every combination out).

The quickest way to do this is algebraically, by first assigning coefficients to the equation:

$aCu + bHNO_3 \rightarrow cCu(NO_3)_2 + dNO + eH_2O$

For nitrogen: $b = 2c + d$.

In this case, only option **E** satisfies $b = 2c + d$.

Note that using copper wouldn't be as useful, as all the options satisfy $a = c$.

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Question 450: D

Alkenes are an organic series and have twice as many hydrogen atoms as carbon atoms. Bromine water is decolourised in their presence and they take part in addition reactions. Alkenes are more reactive than alkanes because they contain a C=C bond.

Question 451: A

Group 17 elements are missing one valence electron, so form negative ions. Bromine is a liquid at room temperature and is also coloured brown. Reactivity decreases as you progress down Group 17, so fluorine reacts more vigorously than iodine. All Group 17 elements are found bound to each other, e.g. F_2 and Cl_2.

Question 452: D

CO poisoning and spontaneous combustion do not occur in the electrolysis of brine. The products of the cathode and anode in the electrolysis of brine are Cl_2 and H_2 respectively. If these two gases react with each other they can form HCl, which is extremely corrosive.

Question 453: D

The hydrogen produced is positively charged and therefore needs to be reduced by the addition of an electron before being released. This happens at the cathode. The chlorine produced is negatively charged and therefore needs to lose electrons. This happens at the anode. NaOH is formed in this process.

Question 454: C

Alkanes are made of chains of singly bonded carbon and hydrogen atoms. C-H bonds are very strong and confer alkanes a great deal of stability. An alkane with 14 hydrogen atoms is called hexane, as it has 6 carbon atoms. Alkanes burn in excess oxygen to produce carbon dioxide and water. Bromine water is decolourised in the presence of alkenes.

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Question 455: E

You've probably got a lot of experience of organic chemistry by now, so this should be fairly straightforward. Alcohols by definition contain an R-OH functional group and because of this polar group they are highly soluble in water. Ethanol is a common biofuel.

Question 456: E

Alkanes are saturated (and therefore non-reducible), have the general formula C_nH_{2n+2} and have no effect on bromine solution. Alkenes are unsaturated (and therefore reducible), have the general formula C_nH_{2n} and turn bromine water colourless because they can undergo an addition reaction with bromine.

Question 457: D

The balanced equation for the reaction between magnesium oxide and hydrochloric acid is:

$MgO + 2HCl \rightarrow MgCl_2 + H_2$

The relative molecular mass of MgO is 24 + 16 = 40g per mole.

Therefore 10g of MgO represents 10/40 = 0.25 moles.

As the ratio of MgO to $MgCl_2$ is 1:1, we know that the amount of $MgCl_2$ produced will also be 0.25 moles. One mole of $MgCl_2$ has a molecular mass of 24 + (2 x 35.5) = 95g per mole.

Therefore the reaction will produce 0.25 x 95 = 23.75g of $MgCl_2$.

Question 458: D

Moving up the alkane series, as size and mass of the molecule increases (and thus the Van der Waals forces increase), the boiling point and viscosity increase and the flammability and volatility decrease. Therefore pentadecane will be more viscous than pentane.

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Question 459: E

All of the factors mentioned will affect the rate of a reaction. A higher temperature causes the particles to move at a higher speed, so they collide more often, which increases the rate of reaction. Collision rate is also increased with a higher concentration of reactants, and with a higher concentration of a catalyst or one with larger surface area, which will provide more active sites, thus increasing the rate of reaction.

Question 460: C

The total atomic mass of the end product is c [12 + (2 x 16)] + d [(2x1) +16] = 44c + 18d

We know that 176 = 44c. Therefore c = 4, and that 108 = 18d so = 6.

Thus, the equation becomes: $C_aH_b + O_2 \rightarrow 4CO_2 + 6H_2O$.

This gives a ratio of 4C to 12H, which is a ratio of 1:3 carbon to hydrogen. This means the unknown hydrocarbon must be a multiple of this ratio. By balancing the equation we can see that the unknown hydrocarbon must be ethane, C_2H_6: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$.

Question 461: A

$C_2H_5OH \rightarrow C_2H_4O$. Thus, ethanol has lost two hydrogen atoms, i.e. has been oxidised. Note that although another substrate may be reduced (therefore making it a redox reaction), ethanol has only been oxidised.

Question 462: B

This is fairly straightforward, but you can save time by doing it algebraically:

For barium: 3a = b

For nitrogen: 2a = c

Let a = 1, thus, b = 3 and c = 2

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Question 463: E

There are 14 oxygen atoms on the left side. Thus: 3b + 2c = 14.

Note also that for sulphur: a = c, and for I

iron: a = 2b.

This sets up an easy trio of simultaneous equations:

Substitute a into the first equation to give: 1.5a + 2a = 14. Thus: a = 14/3.5 = 4.

Therefore, a = c = 4 and b = 2

Question 464: C

The average atomic mass takes the abundances of all isotopes into account:

Mass = (Abundance of Mg^{23}) (Mass Mg^{23}) + (Abundance of Mg^{25}) (Mass Mg^{25}) + (Abundance of Mg^{26}) (Mass Mg^{26})

Mass = 23 x 0.80 + 25 x 0.10 + 26 x 0.10

= 18.4 + 2.5 + 2.6 = 23.5

Question 465: D

Cl_2 and Fe_2O_3 are reduced in their reactions and are therefore oxidising agents. Similarly, CO and Cu^{2+} are oxidised in their reactions and are therefore reducing agents. Cl is a stronger oxidising agent than Br as it is higher up in the reactivity series and will displace negative Br ions from its compounds to form the oxidised Br_2. Mg is a stronger reducing agent than Cu, as it is higher up in the reactivity series. Thus, Mg would displace a positive copper ion from its compound to form copper atoms. Therefore, Mg reduces Cu.

Question 466: C

NaCl is an ionic compound and therefore has a high melting point. It is highly soluble in water but only conducts electricity in solution or as a liquid.

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Question 467: C

The equation for the reaction is: $2NaOH + Zn(NO_3)_2 \rightarrow 2NaNO_3 + Zn(OH)_2$

Therefore, the molar ratio between NaOH and $Zn(OH)_2$ is 2:1.

Molecular Mass of NaOH = 23 + 16 + 1 = 40

Molecular Mass of $Zn(OH)_2$= 65 + 17 x 2 = 99

Thus, the number of moles of NaOH that react = 80/40 = 2 moles.

Therefore, 1 mole of $Zn(OH)_2$ is produced. Mass = 99g per mole x 1 mole = 99g

Question 468: E

Metal + Water → Hydroxide + Hydrogen gas – the reaction is always exothermic. Reactivity increases down the group, so potassium reacts more vigorously with water than sodium. Therefore, all four statements are correct.

Question 469: C

Electrolysis separates NaCl into sodium and chloride ions but not CO_2 (which is a covalently bound gas). Sieves cannot separate ionically bound compounds like NaCl. Dyes are miscible liquids and can be separated by chromatography. Oil and water are immiscible liquids, so a separating funnel is necessary to separate the mixtures. Methane and diesel are separated from each other during fractional distillation, as they have different boiling points.

Question 470: B

The reaction between water and caesium can cause spontaneous combustion and therefore doesn't make the reaction safer. The reaction between caesium and fluoride is highly exothermic and does not require a catalyst. The reaction produces CsF which is a salt.

Question 471: B

The nuclei of larger elements contain more neutrons than protons to reduce the charge density, e.g. Br^{80} contains 35 protons but 45 neutrons. Stable isotopes very rarely undergo radioactive decay.

Question 472: B

Salts tend to form giant ionic structures with strong electrostatic attraction between the positively charged metal ion and the negatively charged non-metal ion.

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Question 473: E

306ml of water is 306g, which is the equivalent of 306g/18g per mole of H_2O = 17 moles. 17 times Avogadro's constant gives the number of molecules present, which is 1.02×10^{25}. There are 10 protons and 10 electrons in each water molecule. Hence there are 1.02×10^{26} protons.

Question 474: D

The number of moles of each element = Mass/Molar Mass. Let the % represent the mass in grams: Hydrogen: 3.45g/1g per mole = 3.45 moles

Oxygen: 55.2g/16g per mole = 3.45 moles

Carbon: 41.4g/12g per mole = 3.45 moles

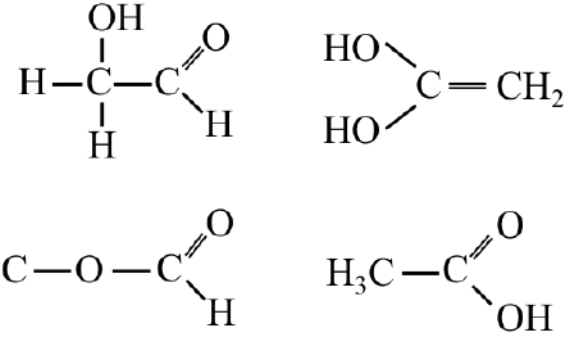
Thus, the molar ratio is 1:1:1. The only option that satisfies this is option D.

Question 475: C

Group 17 elements are non-metals, whilst Group 2 elements are metals. Thus, the Group 17 element must gain electrons when it reacts with the Group 2 element, i.e. B is reduced. The easy way to calculate the formula is to swap the valences of both elements: A is +2 and B is -1. Thus, the compound is AB_2.

Question 476: E

There are 4:



Question 477: A

A catalyst is unused in a chemical reaction and lowers the activation energy of a chemical reaction but does not move the equilibrium position.

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Question 478: B

The $H^{\delta+}$ ion is attracted to the electron rich carbon double bond, which starts the reaction off, hence it is an electrophile.

Question 479: C

The conditions are 450°C, 200 atmospheres pressure and an iron catalyst. This is something you just have to memorise.

Question 480: C

Having a high temperature in this situation will in fact shift the equilibrium position in the backwards direction thus decreasing the yield of the reaction. However, if the temperature is low, thus increasing the yield of the desired product, the reaction rate will be too slow, which would mean a poor yield over time. Hence, the temperature is kept high to keep the reaction rate high.

Question 481: D

In **1** and **4** the oxidation states remain the same. Whereas in **2**, calcium is oxidised and oxygen is reduced. In **3** hydrogen is reduced and calcium is oxidised.

Question 482: A

A smaller atomic radius and larger nuclear charge both increase the electrostatic forces between the boding pair of electrons and the nucleus, thus increasing electronegativity. **4** and **5** actively decrease electronegativity, as it makes this electrostatic force weaker and **3** has no effect on electronegativity.

Question 483: C

Amines contain nitrogen, and only a nitrile contains nitrogen in the possible answers.

Question 484: C

A benzene ring can't undergo elimination. The iodine ion is most susceptible to elimination as its nucleus is the least strongly attracted to the bonding pair as it is the largest and most shielded group in the answers.

Question 485: E

Gibbs free energy dictates if a reaction will be spontaneous or not. A reaction will only be so if the value for Gibbs free energy is negative.

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Question 486: C

A Lewis base is a lone pair donor and only in reaction **2** does A donate a lone pair.

Question 487: D

Equating the number of nitrogens, we get 4 = b. Equating the number of hydrogens, we get that c = 6. Equating the number of oxygens, we find that 2a = b + c. Plugging in the values for b and c, we find that a = 5.

Question 488: A

By equating the amounts of the various elements, we find that the following equations must hold:

① 2a + 4b = d + e

② 4a = d

③ 2c = 4d + 3e

④ c = 4e

Putting ④ into ③ yields

8e = 4d + 3e, 5e = 4d

Subbing ② into this yields

5e = 16a

Subbing all into ① yields

32b = 13e

Say e = 1 then a = $\frac{5}{16}$, b = $\frac{13}{32}$, c = 4, d = $\frac{5}{4}$. Then to get whole numbers we must multiply them all by 32 making b =13.

Question 489: B

Before and during the rate determining step, **A** and **B** appear twice as they form **C**, which is required twice, and **D** appears once hence their respective powers.

Question 490: D

The water is polar so in both instances there is a side of the water that will be attracted to the oppositely charged balloon or wool. This will cause the water stream to move towards both objects.

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Question 491: D

A, **B** and **C** are intermolecular forces and are comparatively very weak to **D** and **E**. Covalent bonding is stronger than ionic bonding; this is due to the bond length being considerably shorter in covalent bonds compared to ionic bonds.

Question 492: A

The central oxygen atom has 2 lone pairs and 2 bonding pairs. This leads to a tetrahedral like arrangement. The lone pairs repel each other and the bonding pairs more than the bonding pairs repel each other, causing the bond angle between the 2 bonding pairs to be smaller than you would expect in a normal tetrahedral arrangement (109.5°). Each bonding pair "squeezes" the bond angle by roughly 2.5°, making the bond angle 104.5°.

Question 493: B

Diamond is a macromolecular structure meaning strong covalent bonds must be broken in order for it to melt, and covalent bonds require a lot of energy to break compared to other bonds.

Question 494: A

A fluoroalkane will be less susceptible to substitution than a bromoalkene, as the fluorine is very strongly bonded to the carbon compared to the bromine. A primary carbocation is very unstable so will not want to be formed, thus making the primary fluoroalkane less susceptible than the tertiary and secondary version.

Question 495: E

The middle carbon atom is chiral, so there are 2 products that are mirror images of each other.

Question 496: E

This is E-Z isomerism, which occurs when two structures have the sane molecular and structural formula, but the functional groups attached to two carbon atoms joined by a double bond are arranged differently. The functional groups must be different for E-Z isomerism to be present.

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Question 497: C

68% of the compound is the metal, therefore 32% is oxygen. The three oxygens weigh 48.0 and this represents 31.96% of the total weight. Therefore, the total weight is 48 ÷ 0.32 = 150. Subtract 48 from 150 to get 102, which is the weight contribution of M_2. Dividing by two gets 51, which must be the molar mass of M.

Question 498: D

Moles of O_2 = 0.64 ÷ 32.0 = 0.02. The CX_4 to O_2 ratio is 1 to 2. Therefore, half as many moles of CX_4 are required than moles of oxygen required so 0.01 moles of CX_4 react.

9.0 ÷ 0.01 = 900. This is the molecular weight of CX_4. Subtract 12 from 900 to get 888, which is the weight contribution of X_4. Dividing by four gets 222 which is the molar mass of X.

Question 499: A

Mass of oxygen: 4.1 - 2.5 = 1.6g

Moles of oxygen: 1.26 ÷ 16 = 0.0788

Mass of chlorine: $2.5 \times \frac{36}{39.+36} = 1.2g$

Moles of chlorine: 1.2 ÷ 36 = 0.0333…

Mass of potassium: $2.5 \times \frac{39}{39+36} = 1.3g$

moles of potassium: 1.3 ÷ 39 = 0.0333 ...

Divide moles by smallest factor (which is 0. 0333.):

O = 3

Cl = 1

K = 1

Hence, the formula is $KClO_3$

Question 500: A

Only **A** has a carbon with 4 different functional groups attached.

Question 501: E

That the amplitude of a wave determines its mass is false. Waves are not objects and do not have mass.

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Question 502: A

We know that:

Displacement s = 30 m

Initial speed u = 0 ms^{-1}

Acceleration a = 5.4 ms^{-2}

Final speed v = ?

Time t = ?

And that $v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 5.4 \times 30$

$v^2 = 324$ so v = 18 ms^{-1}

$s = ut + 1/2\ at^2$

So $30 = 1/2 \times 5.4 \times t^2$

$t^2 = 30/2.7$ so t = 3.3 s

Question 503: D

The wavelength is given by velocity $v = \lambda f$

Frequency is given by $f = 1/T$

So $v = \lambda/T$ giving wavelength $\lambda = vT$

The period T = 49 s/7 So $\lambda = 5\ ms^{-1} \times 7\ s = 35\ m$

Question 504: E

This is a straightforward question as you only have to put the numbers into the equation (made harder by the numbers being hard to work with).

$$\text{Power} = \frac{\text{Force x Distance}}{\text{Time}} = \frac{375\ N \times 1.3\ m}{5\ s}$$

$= 75 \times 1.3 = 97.5\ W$

Question 505: E

$v = u + at$

$v = 0 + 5.6 \times 8 = 44.8\ ms^{-1}$

And $s = ut + \frac{at^2}{2} = 0 + 5.6 \times \frac{8^2}{2} = 179.2$

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Question 506: C

The sky diver leaves the plane and will accelerate until the air resistance equals their weight – this is their terminal velocity. The sky diver will accelerate under the force of gravity. If the air resistance force exceeded the force of gravity the sky diver would accelerate away from the ground, and if it was less than the force of gravity they would continue to accelerate toward the ground.

Question 507: D

$s = 20$ m, $u = 0$ ms^{-1}, $a = 10$ ms^{-2}

$v^2 = u^2 + 2as$

$v^2 = 0 + 2 \times 10 \times 20$

$v^2 = 400$ so $v = 20$ ms^{-1}

Momentum = Mass x velocity = $20 \times 0.1 = 2$ kgms^{-1}

Question 508: E

Electromagnetic waves have varying wavelengths and frequencies and their energy is proportional to their frequency.

Question 509: D

The total resistance = $R + r = 0.8 + 1 = 1.8\ \Omega$

and $I = \frac{\text{e.m.f}}{\text{total resistance}} = \frac{36}{1.8} = 20$ A

Question 510: D

Use Newton's second law and remember to work in SI units:

So Force = mass x acceleration = mass $\times \frac{\Delta\text{velocity}}{\text{time}}$

$= 20 \times 10^{-3} \times \frac{100 - 0}{10 \times 10^{-3}}$

$= 200$ N

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Question 511: E

In this case, the work being done is moving the bag 0.7 m.

Work Done = Bag's Weight x Distance = 50 x 10 x 0.7 = 350 N

Power = $\frac{\text{Work}}{\text{Time}} = \frac{350}{3} = 116.7$ W

= 117 W to 3 significant figures

Question 512: B

Firstly, use P = Fv to calculate the power [Ignore the frictional force as we are not concerned with the resultant force here].

So P = 300 x 30 = 9000 W

Then, use P = IV to calculate the current.

I = P/V = 9000/200 = 45 A

Question 513: C

Work is defined as W = F x s. Work can also be defined as work = force x distance moved in the direction of force.

Work is measured in joules and 1 Joule = 1 Newton x 1 Metre, and 1 Newton = 1 Kg x ms^{-2} [F = ma].

Thus, 1 Joule = Kgm^2s^{-2}

Question 514: E

Joules are the unit of energy (and also Work = Force x Distance). Thus, 1 Joule = 1 N x 1 m.

Pa is the unit of pressure (= Force/Area). Thus, Pa = N x m^{-2}. So J = Nm^{-2} x m^3 = Pa x m^3. Newton's third law describes that every action produces an equal and opposite reaction. For this reason, the energy required to decelerate a body is equal to the amount of energy it possesses during movement, i.e. its kinetic energy, which is defined correctly in statement **I**.

Question 515: D

Alpha radiation is of the lower energy, as it represents the movement of a fairly large particle consisting of 2 neutrons and 2 protons. Beta radiation consists of high-energy, high-speed electrons or positrons.

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Question 516: E

The half-life does depend on atom type and isotope, as these parameters significantly impact on the physical properties of the atom in general, so statement **1** is false. Statement **2** is the correct definition of half-life. Statement **3** is also correct: half-life in exponential decay will always have the same duration, independent of the quantity of the matter in question; in non-exponential decay, half-life is dependent on the quantity of matter in question.

Question 517: A

In contrast to nuclear fission, where neutrons are shot at unstable atoms, nuclear fusion is based on the high speed, high-temperature collision of molecules, most commonly hydrogen, to form a new, stable atom while releasing energy.

Question 518: E

Nuclear fission releases a significant amount of energy, which is the basis of many nuclear weapons. Shooting neutrons at unstable atoms destabilises the nuclei, which in turn leads to a chain reaction and fission. Nuclear fission can lead to the release of ionizing gamma radiation.

Question 519: D

The total resistance of the circuit would be twice the resistance of one resistor and proportional to the voltage, as given by Ohm's Law. Since it is a series circuit, the same current flows through each resistor and since they are identical, the potential difference across each resistor will be the same.

Question 520: E

The distance between Earth and the Sun = Time x Speed = 60 x 8 seconds x 3×10^8 ms^{-1} = $480 \times 3 \times 10^8$ m

Approximately = $1500 \times 10^8 = 1.5 \times 10^{11}$ m.

The circumference of Earth's orbit around the sun is given by $2\pi r = 2 \times 3 \times 1.5 \times 10^{11} = 9 \times 10^{11} = 10^{12}$ m

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Question 521: E

Speed is a scalar quantity whilst velocity is a vector describing both magnitude and direction. Speed describes the distance a moving object covers over time (i.e. speed = distance/time), whereas velocity describes the rate of change of the displacement of an object (i.e. velocity = displacement/time). The internationally standardised unit for speed is meters per second (ms^{-1}), while ms^{-2} is the unit of acceleration.

Question 522: E

Ohm's Law only applies to conductors and can be mathematically expressed as $V \alpha I$. The easiest way to do this is to write down the equations for statements **C**, **D** and **E**.

C: $I \alpha \frac{I}{V}$

D: $I \alpha V^2$

E: $I \alpha V$.

Thus, statement **E** is correct.

Question 523: E

Any object at rest is not accelerating and therefore has no resultant force. Strictly speaking, Newton's second law is actually: force = rate of change of momentum, which can be mathematically manipulated to give statement **2**:

$$\text{Force} = \frac{\text{momentum}}{\text{time}} = \frac{\text{mass x velocity}}{\text{time}} = \text{mass x acceleration}$$

Question 524: D

Statement **3** is incorrect, as charge = current x time. Statement **1** substitutes $I = \frac{V}{R}$ and statement **2** substitutes $I = \frac{P}{V}$.

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Question 525: E

Weight of elevator + people = mg = 10 x (1600 + 200) = 18,000 N

Thus, the resultant force is given by:

F_M = Motor Force – [Frictional Force + Weight]

F_M = M – 4,000 – 18,000

Use Newton's second law to give: F_M = M – 22,000 N = ma

Thus, M – 22,000 N = 1,800a

Since the lift must accelerate at $1 ms^{-2}$:

M = 1,800 kg x 1 ms^{-2} + 22,000 N

M = 23,800 N

Question 526: D

Total Distance = Distance during acceleration phase + Distance during braking phase

Distance during acceleration phase is given by:

$$s = ut + \frac{at^2}{2} = 0 + \frac{5 \times 10^2}{2} = 250 \text{ m}$$

$v = u + at = 0 + 5 \times 10 = 50 \text{ ms}^{-1}$

And use $a = \frac{v-u}{t}$ to calculate the deceleration: $a = \frac{0 - 50}{20} = -2.5 \text{ ms}^{-2}$

Distance during the deceleration phase is given by:

$$s = ut + \frac{at^2}{2} = 50 \times 20 + \frac{-2.5 \times 20^2}{2} = 1000 - \frac{2.5 \times 400}{2}$$

s = 1000 - 500 = 500 m

Thus, total distance = 250 + 500 = 750 m

Question 527: E

It is not possible to calculate the power of the heater as we don't know the current that flows through it or its internal resistance. The 8 ohms refers to the external copper wire and not the heater. Whilst it's important that you know how to use equations like P = IV, it's more important that you know when you ***can't*** use them!

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Question 528: E

This question has a lot of numbers but not any information on time, which is necessary to calculate power. You cannot calculate power by using P = IV as you don't know how many electrons are accelerated through the potential difference per unit time. Thus, more information is required to calculate the power.

Question 529: B

When an object is in equilibrium with its surroundings, it radiates and absorbs energy at the same rate and so its temperature remains constant i.e. there is no *net* energy transfer. Radiation is slower than conduction and convection.

Question 530: A

The work done by the force is given by:
Work Done = Force x Distance = 12 N x 3 m = 36 J

Since the surface is frictionless, Work Done = Kinetic Energy.

$E_k = \frac{mv^2}{2} = \frac{6v^2}{2}$

Thus, $36 = 3v^2$

$v = \sqrt{12} = \sqrt{4}\sqrt{3} = 2\sqrt{3}$ ms^{-1}

Question 531: C

Total energy supplied to water = Change in temperature x Mass of water x 4,000 J
= 40 x 1.5 x 4,000 = 240,000 J

Power of the heater = $\frac{\text{Work Done}}{\text{time}} = \frac{240{,}000}{50 \times 60} = \frac{240{,}000}{3{,}000} = 80$ W

Using $P = IV = \frac{V^2}{R}$:

$R = \frac{V^2}{P} = \frac{100^2}{80} = \frac{10{,}000}{80} = 125$ ohms

Question 532: E

The large amount of energy released during atomic fission is the basis underlying nuclear power plants. Splitting an atom into two or more parts will, by definition, produce molecules of different sizes than the original atom, thereby producing two new atoms. The free neutrons and photons produced by the splitting of atoms form the basis of the energy release.

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Question 533: D

Gravitational potential energy is just an extension of the equation work done = force x distance (force is the weight of the object, mg, and distance is the height, h). The reservoir in statement **3** would have a potential energy of 10^{10} Joules i.e. 10 Giga Joules ($E_p = 10^6$ kg x 10 N x 10^3 m).

Question 534: D

Statement **1** is the common formulation of Newton's third law. Statement **2** presents a consequence of the application of Newton's third law. Statement **3** is false: rockets can still accelerate because the products of burning fuel are ejected in the opposite direction from which the rocket needs to accelerate.

Question 535: E

Positively charged objects have lost electrons.

Charge = Current x Time = $\frac{\text{Voltage}}{\text{Resistance}}$ x Time.

Objects can become charged by friction as electrons are transferred from one object to the other.

Question 536: B

Each body of mass exerts a gravitational force on another body with mass. This is true for all planets as well. Gravitational force is dependent on the mass of both objects. Satellites stay in orbit due to centripetal force that acts tangentially to gravity (not because of the thrust from their engines). Two objects will only land at the same time if they also have the same shape or they are in a vacuum (as otherwise air resistance would result in different terminal velocities).

Question 537: A

Metals conduct electrical charge easily and provide little resistance to the flow of electrons. Charge can also flow in several directions. However, all conductors have an internal resistance and therefore provide some resistance to electrical charge.

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Question 538: E

First, calculate the rate of petrol consumption:

$$\frac{\text{Speed}}{\text{Consumption}} = \frac{60 \text{ miles/hour}}{30 \text{ miles/gallon}} = 2 \text{ gallons/hour}$$

Therefore, the total power is: 2 gallons = $2 \times 9 \times 10^8 = 18 \times 10^8$J

1 hour = $60 \times 60 = 3600$ s

$$\text{Power} = \frac{\text{Energy}}{\text{Time}} = \frac{18 \times 10^8}{3600}$$

$$P = \frac{18}{36} \times 10^6 = 5 \times 10^5 \text{ W}$$

Since efficiency is 20%, the power delivered to the wheels = $5 \times 10^5 \times 0.2 = 10^5$ W = 100 kW

Question 539: D

Beta radiation is stopped by a few millimetres of aluminium, but not by paper. In β^- radiation, a neutron changes into a proton plus an emitted electron. This means the atomic mass number remains unchanged.

Question 540: E

Firstly, calculate the mass of the car $= \frac{\text{Weight}}{g} = \frac{15{,}000}{10} = 1{,}500$ kg

Then using $v = u + at$ where $v = 0$ ms^{-1}, $u = 15$ ms^{-1} and $t = 10 \times 10^{-3}$ s

$$a = \frac{0 - 15}{0.01} = 1500 \text{ ms}^{-2}$$

$F = ma = 1500 \times 1500 = 2\,250\,000$ N

Question 541: E

Electrical insulators offer high resistance to the flow of charge. Insulators are usually non-metals; metals conduct charge very easily. Since charge does not flow easily to even out, insulators can be charged with friction.

Question 542: A

The car accelerates for the first 10 seconds at a constant rate and then decelerates after t = 30 seconds. It does not reverse, as the velocity is not negative.

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Question 543: B

The distance travelled by the car is represented by the area under the curve (integral of velocity) which is given by the area of two triangles and a rectangle:

Area $= \left(\frac{1}{2} \times 10 \times 10\right) + (20 \times 10) + \left(\frac{1}{2} \times 10 \times 10\right)$

Area = 50 + 200 + 50 = 300 m

Question 544: C

Using the equation force = mass x acceleration, where the unknown acceleration = change in velocity over change in time.

Hence: $\frac{F}{m} = \frac{\text{change in velocity}}{\text{change in time}}$

We know that F = 10,000 N, mass = 1,000 kg and change in time is 5 seconds.

So, $\frac{10{,}000}{1{,}000} = \frac{\text{change in velocity}}{5}$

So change in velocity = 10 x 5 = 50 m/s

Question 545: D

This question tests both your ability to convert unusual units into SI units and to select the relevant values (e.g. the crane's mass is not important here).

0.01 tonnes = 10 kg; 100 cm = 1 m; 5,000 ms = 5 s

Power $= \frac{\text{Work Done}}{\text{Time}} = \frac{\text{Force x Distance}}{\text{Time}}$

In this case the force is the weight of the wardrobe = 10 x g = 10 x 10 = 100N

Thus, Power = $\frac{100 \times 1}{5}$ = 20 W

Question 546: E

Remember that the resistance of a parallel circuit (R_T) is given by: $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

Thus, $\frac{1}{R_T} = \frac{1}{1} + \frac{1}{2} = \frac{3}{2}$ and therefore $R = \frac{2}{3}\ \Omega$

Using Ohm's Law: $I = \frac{20\ V}{\frac{2}{3}\ \Omega} = 20 \times \frac{3}{2}$ = 30 A

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Question 547: E

Water is denser than air. Therefore, the speed of light decreases when it enters water and increases when it leaves water. The direction of light also changes when light enters/leaves water. This phenomenon is known as refraction and is governed by Snell's Law.

Question 548: C

The voltage in a parallel circuit is the same across each branch, i.e. Branch *A* Voltage = Branch *B* Voltage.

The resistance of Branch *A* = 6 x 5 = 30 Ω

The resistance of Branch *B* = 10 x 2 = 20 Ω.

Using Ohm's Law: I= V/R.

Thus, $I_A = \frac{60}{30} = 2$ A; $I_B = \frac{60}{20} = 3$ A

Question 549: C

This is a very straightforward question made harder by the awkward units you have to work with. Ensure you are able to work comfortably with prefixes of 10^9 and 10^{-9} and convert without difficulty.

50,000,000,000 nano Watts = 50 W and 0.000000004 Giga Amperes = 4 A.

Using P = IV: $V = \frac{P}{I} = \frac{50}{4} = 12.5$ V = 0.0125 kV

Question 550: B

Radioactive decay is highly random and unpredictable. Only gamma decay releases gamma rays and few types of decay release X-rays. The electrical charge of an atom's nucleus decreases after alpha decay as two protons are lost.

Question 551: D

Using P = IV: $I = \frac{P}{V} = \frac{60}{15} = 4$ A

Now using Ohm's Law: $R = \frac{V}{I} = \frac{15}{4} = 3.75$ Ω

So, each resistor has a resistance of $\frac{3.75}{3} = 1.25$ Ω.

If two more resistors are added, the overall resistance = 1.25 x 5 = 6.25 Ω

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Question 552: E

There is not enough information to answer this question. We would be required to know the resistive forces acting against the tractor and if there is any change in height in order to calculate the useful work done and hence the efficiency.

Question 553: E

Electromagnetic induction is defined by statements **1** and **2**. An electrical current is generated when a coil moves in a magnetic field.

Question 554: D

An ammeter will always give the same reading in a series circuit, not in a parallel circuit where current splits at each branch in accordance with Ohm's Law.

Question 555: D

Electrons move in the opposite direction to current (i.e. they move from negative to positive).

Question 556: A

For a fixed resistor, the current is directly proportional to the potential difference. For a filament lamp, as current increases, the metal filament becomes hotter. This causes the metal atoms to vibrate and move more, resulting in more collisions with the flow of electrons. This makes it harder for the electrons to move through the lamp and results in increased resistance. Therefore, the graph's gradient decreases as current increases.

Question 557: E

Vector quantities consist of both direction and magnitude, e.g. velocity, displacement, etc., and can be added by taking account of direction in the sum.

Question 558: C

The gravity on the moon is 6 times less than 10 ms^{-2}. Thus, $g_{moon} = \frac{10}{6} = \frac{5}{3}$ ms^{-2}.

Since weight = mass x gravity, the mass of the rock = $\frac{250}{\frac{5}{3}} = \frac{750}{5} = 150$ kg

Therefore, the density $= \frac{\text{mass}}{\text{volume}} = \frac{150}{250} = 0.6$ kg/cm^3

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Question 559: D

An alpha particle consists of a helium nucleus. Thus, alpha decay causes the mass number to decrease by 4 and the atomic number to decrease by 2. Five iterations of this would decrease the mass number by 20 and the atomic number by 10.

Question 560: C

Using Ohm's Law: The potential difference entering the transformer (V_1) = 10 x 20 = 200 V

Now use $\frac{N1}{N2} = \frac{V1}{V2}$ to give: $\frac{5}{10} = \frac{200}{V2}$

Thus, $V_2 = \frac{2,000}{5}$ = 400 V

Question 561: D

For objects in free fall that have reached terminal velocity, acceleration = 0.

Thus, the sphere's weight = resistive forces.

Using Work Done = Force x Distance

Force = 10,000 J/100 m = 100 N.

Therefore, the sphere's weight = 100 N

Since g = 10ms^{-2}, the sphere's mass = 10 kg

Question 562: E

The wavelength of ultraviolet waves is longer than that of x-rays. Wavelength is inversely proportional to frequency. Most electromagnetic waves are not stopped with aluminium (they usually require thick lead to stop them), and they travel at the speed of light. Humans can only see a very small part of the spectrum.

Question 563: B

If an object moves towards the sensor, the wavelength will appear to decrease and the frequency increase. The faster this happens, the faster the increase in frequency and decrease in wavelength.

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Question 564: A

Acceleration = $\frac{\text{Change in Velocity}}{\text{Time}} = \frac{1{,}000}{0.1} = 10{,}000\ ms^{-2}$

Using Newton's second law: The Braking Force = Mass x Acceleration.

Thus, Braking Force = 10,000 x 0.005 = 50 N

Question 565: C

Polonium has undergone alpha decay. Thus, *Y* is a helium nucleus and contains 2 protons and 2 neutrons.

Therefore, 10 moles of *Y* contain $2 \times 10 \times 6 \times 10^{23}$ protons = $120 \times 10^{23} = 1.2 \times 10^{25}$ protons.

Question 566: C

The rod's activity is less than 1,000 Bq after 300 days. In order to calculate the longest possible half-life, we must assume that the activity is just below 1,000 Bq after 300 days. Thus, the half-life has decreased activity from 16,0 00 Bq to 1,000 Bq in 300 days.

After one half-life: Activity = 8,000 Bq

After two half-lives: Activity = 4,000 Bq

After three half-lives: Activity = 2,000 Bq

After four half-lives: Activity = 1,000 Bq

Thus, the rod has halved its activity a minimum of 4 times in 300 days.

300/4 = 75 days

Question 567: E

There is no change in the atomic mass or proton numbers in gamma radiation. In β decay, a neutron is transformed into a proton (and an electron is released). This results in an increase in proton number by 1 but no overall change in atomic mass. Thus, after 5 rounds of beta decay, the proton number will be 89 + 5 = 94 and the mass number will remain at 200. Therefore, there are 94 protons and 200-94 = 106 neutrons.

NB: You are not expected to know about β^+ decay.

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Question 568: C

Calculate the speed of the sound $= \frac{\text{distance}}{\text{time}} = \frac{500}{1.5} = 333\ ms^{-1}$

Thus, the wavelength $= \frac{\text{Speed}}{\text{Frequency}} = \frac{333}{440}$

Approximate 333 to 330 to give: $\frac{330}{440} = \frac{3}{4} = 0.75$ m

Question 569: B

Firstly, note the all the answer options are a magnitude of 10 apart. Thus, you don't have to worry about getting the correct numbers as long as you get the correct power of 10. You can therefore make your life easier by rounding, e.g. approximate π to 3, etc.

The area of the shell = πr^2.

$= \pi \times (50 \times 10^{-3})^2 = \pi \times (5 \times 10^{-2})^2$

$= \pi \times 25 \times 10^{-4} = 7.5 \times 10^{-3}\ m^2$

The deceleration of the shell $= \frac{u - v}{t} = \frac{200}{500 \times 10^{-6}} = 0.4 \times 10^6\ ms^{-2}$

Then, using Newton's Second Law: braking force = mass x acceleration = $1 \times 0.4 \times 10^6 = 4 \times 10^5 N$

Finally: Pressure $= \frac{\text{Force}}{\text{Area}} = \frac{4 \times 10^5}{7.5 \times 10^{-3}} = \frac{8}{15} \times 10^8\ Pa \approx 5 \times 10^7\ Pa$

Question 570: B

The fountain transfers 10% of 1,000 J of energy per second into 120 litres of water per minute. Thus, it transfers 100 J into 2 litres of water per second.

Therefore, the Total Gravitational Potential Energy, $E_p = mg\Delta h$

Thus, $100\ J = 2 \times 10 \times h$

Hence, $h = \frac{100}{20} = 5$ m

Question 571: E

In step down transformers, the number of turns of the primary coil is larger than that of the secondary coil to decrease the voltage. If a transformer is 100% efficient, the electrical power input = electrical power output ($P = IV$).

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Question 572: C

The percentage of C^{14} in the bone halves every 5,730 years. Since it has decreased from 100% to 6.25%, it has undergone 4 half-lives. Thus, the bone is 4 x 5,730 years old = 22,920 years

Question 573: E

This is a straightforward question in principle, as it just requires you to plug the values into the equation: Velocity = Wavelength x Frequency – Just ensure you work in SI units to get the correct answer.

Frequency = $\frac{2 \text{ m/s}}{2.5 \text{ m}}$ = 0.8 Hz = 0.8 x 10^{-6}MHz = 8 x 10^{-7} MHz

Question 574: E

If an element has a half-life of 25 days, its BQ value will be halved every 25 days.

A total of 350/25 = 14 half-lives have elapsed. Thus, the count rate has halved 14 times. Therefore, to calculate the original rate, the final count rate must be doubled 14 times

Original count rate = 50 x 2^{14}.

$2^{14} = 2^5 \times 2^5 \times 2^4 = 32 \times 32 \times 16 = 16{,}384$.

Therefore, the original count rate = 16,384 x 50 = 819,200

Question 575: D

Remember that V = IR = $\frac{P}{I}$ and Power = $\frac{\text{Work Done}}{\text{Time}} = \frac{\text{Force x Distance}}{\text{Time}}$ = Force x Velocity

Thus, **A** is derived from: V = IR,

B is derived from: $= \frac{P}{I}$,

C is derived from: Voltage = $\frac{\text{Power}}{\text{Current}} = \frac{\text{Force x Velocity}}{\text{Current}}$,

Since Charge = Current x Time, **E** is derived from: Voltage = $\frac{\text{Power}}{\text{Current}} = \frac{\text{Force x Distance}}{\text{Time x Current}} = \frac{J}{As} = \frac{J}{C}$,

D is incorrect as Nm = J. Thus the correct variant would be NmC^{-1}

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Question 576: B

Each three-block combination is mutually exclusive to any other combination, so the probabilities are added. Each block pick is independent of all other picks, so the probabilities can be multiplied. For this scenario there are three possible combinations:

P(2 red blocks and 1 yellow block) = P(red then red then yellow) + P(red then yellow then red) + P(yellow then red then red) =

$$\left(\frac{12}{20} \times \frac{11}{19} \times \frac{8}{18}\right) + \left(\frac{12}{20} \times \frac{8}{19} \times \frac{11}{18}\right) + \left(\frac{8}{20} \times \frac{12}{19} \times \frac{11}{18}\right) =$$

$$\frac{3 \times 12 \times 11 \times 8}{20 \times 19 \times 18} = \frac{44}{95}$$

Question 577: C

Multiply through by 15: $3(3x+5)+5(2x-2) = 18 \times 15$

Thus: $9x + 15 + 10x - 10 = 270$

$9x + 10x = 270 - 15 + 10$

$19x = 265$

$x = 13.95$

Question 578: C

This is a rare case where you need to factorise a complex polynomial:

$(3x - 4)(x + 5) = 0$

$3x - 4 = 0$, so $x = \frac{4}{3}$

$x + 5 = 0$, so $x = -5$

Question 579: C

$$\frac{5(x - 4)}{(x + 2)(x - 4)} + \frac{3(x + 2)}{(x + 2)(x - 4)}$$

$$= \frac{5x - 20 + 3x + 6}{(x + 2)(x - 4)}$$

$$= \frac{8x - 14}{(x + 2)(x - 4)}$$

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Question 580: E

$p \propto \sqrt[3]{q}$, so $p = k\sqrt[3]{q}$

$p = 12$ when $q = 27$

So $12 = k\sqrt[3]{27}$

$12 = 3k$ and $k = 4$

So, $p = 4\sqrt[3]{q}$

Now $p = 24$:

$24 = 4\sqrt[3]{q}$

$6 = \sqrt[3]{q}$ and $q = 6^3 = 216$

Question 581: A

$8 \times 9 = 72$

$8 = (4 \times 2) = 2 \times 2 \times 2$

$9 = 3 \times 3$

$(2 \times 2 \times 2 \times 3 \times 3)^2 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3 = 2^6 \times 3^4$

Question 582: C

Note that $1.151 \times 2 = 2.302$.

Thus: $\frac{2 \times 10^5 + 2 \times 10^2}{10^{10}} = 2 \times 10^{-5} + 2 \times 10^{-8}$

$= 0.00002 + 0.00000002 = 0.00002002$

Question 583: E

$y^2 + ay + b$

$(y + 2)^2 - 5 = y^2 + 4y + 4 - 5$

$y^2 + 4y + 4 - 5 = y^2 + 4y - 1$

So $a = 4$ and $y = -1$

Question 584: E

Take $5(m + 4n)$ as a common factor to give: $\frac{4(m + 4n)}{5(m + 4n)} + \frac{5(m - 2n)}{5(m + 4n)}$

Simplify to give: $\frac{4m + 16n + 5m - 10n}{5(m + 4n)} = \frac{9m + 6n}{5(m + 4n)} = \frac{3(3m + 2n)}{5(m + 4n)}$

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Question 585: C

$A \propto \frac{1}{\sqrt{B}}$. Thus, $= \frac{k}{\sqrt{B}}$.

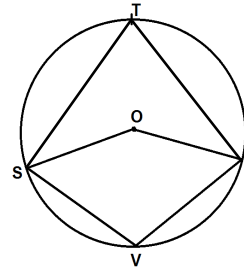
Substitute the values in to give: $4 = \frac{k}{\sqrt{25}}$.

Thus, k = 20.

Therefore, $A = \frac{20}{\sqrt{B}}$.

When B = 16, $A = \frac{20}{\sqrt{16}} = \frac{20}{4} = 5$

Question 586: E



Angles SVU and STU are opposites and add up to 180°, so STU = 91°

The angle of the centre of a circle is twice the angle at the circumference so SOU = 2 x 91° = 182°

Question 587: E

First, we need to calculate the scale factor of enlargement.

$$\frac{\text{B (Surface area)}}{\text{A (Surface area)}} = \frac{32\pi}{8\pi} = 4$$

Because we looked at surface area, the scale factor of enlargement is $\sqrt{4} = 2$.

Now, we can calculate the volume of B by multiplying the volume of A by the cube of the scale factor of enlargement.

$2\pi \times 2^3 = 2\pi \times 8 = 16\pi$

Question 588: E

$$= \frac{8}{x(3-x)} - \frac{6(3-x)}{x(3-x)}$$

$$= \frac{8 - 18 + 6x}{x(3-x)}$$

$$= \frac{6x - 10}{x(3-x)}$$

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Question 589: B

For the black ball to be drawn in the last round, white balls must be drawn every round. Thus the probability is given by $P = \frac{9}{10} \times \frac{8}{9} \times \frac{7}{8} \times \frac{6}{7} \times \frac{5}{6} \times \frac{4}{5} \times \frac{3}{4} \times \frac{2}{3} \times \frac{1}{2}$

$= \frac{9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1}{10 \times 9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1} = \frac{1}{10}$

Question 590: C

The probability of getting a king the first time is $\frac{4}{52} = \frac{1}{13}$, and the probability of getting a king the second time is $\frac{3}{51}$. These are independent events, so the probability of drawing two kings is $\frac{1}{13} \times \frac{3}{51} = \frac{3}{663} = \frac{1}{221}$

Question 591: B

The probabilities of all outcomes must sum to one, so if the probability of rolling a 1 is x, then: $x + x + x + x + 2x = 1$. Therefore, $x = \frac{1}{7}$.

The probability of obtaining two sixes $P_{12} = \frac{2}{7} \times \frac{2}{7} = \frac{4}{49}$

Question 592: B

There are plenty of ways of counting, however the easiest is as follows: 0 is divisible by both 2 and 3. Half of the numbers from 1 to 36 are even (i.e. 18 of them). 3, 9, 15, 21, 27, 33 are the only numbers divisible by 3 that we've missed. There are 25 outcomes divisible by 2 or 3, out of 37.

Question 593: C

List the six ways of achieving this outcome: HHTT, HTHT, HTTH, and TTHH, THTH, THHT. There are 2^4 possible outcomes for 4 consecutive coin flips, so the probability of two heads and two tails is: $6 \times \frac{1}{2^4} = \frac{6}{16} = \frac{5}{8}$

	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

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Question 594: D

Count the number of ways to get a 5, 6 or 7 (draw the square if helpful). The ways to get a 5 are: 1, 4; 2, 3; 3, 2; 4, 1.
The ways to get a 6 are: 1, 5; 2, 4; 3, 3; 4, 2; 5, 1.
The ways to get a 7 are: 1, 6; 2, 5; 3, 4; 4, 3; 5, 2; 6, 1.
That is 15 out of 36 possible outcomes, so the probability is:
15/36 = 5/12

Question 595: C

There are x + y + z balls in the bag. The probability of picking a red ball is $\frac{x}{(x+y+z)}$ and the probability of picking a green ball is $\frac{z}{(x+y+z)}$. These are independent events, so the probability of picking red then green is $\frac{xz}{(x+y+z)^2}$ and the probability of picking green then red is the same. These outcomes are mutually exclusive, so are added.

Question 596: B

There are two ways of doing it, pulling out a red ball then a blue ball, or pulling out a blue ball and then a red ball. Let us work out the probability of the first: $\frac{x}{(x+y+z)} \times \frac{y}{x+y+z-1}$, and the probability of the second option will be the same. These are mutually exclusive options, so the probabilities are summed.

Question 597: A

[x: Player 1 wins point, y: Player 2 wins point]
Player 1 wins in five rounds if we get: yxxxx, xyxxx, xxyxx, xxxyx.
(Note the case of xxxxy would lead to player 1 winning in 4 rounds, which the question forbids.)
Each of these have a probability of $p^4(1-p)$. Thus, the solution is $4p^4(1-p)$.

Question 598: E

$4x + 7 + 18x + 20 = 14$
$22x + 27 = 14$
Thus, $22x = -13$
Giving $x = -\frac{13}{22}$

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Question 599: D

$r^3 = \frac{3V}{4\pi}$

Thus, $r = \left(\frac{3V}{4\pi}\right)^{1/3}$

Therefore, $S = 4\pi\left[\left(\frac{3V}{4\pi}\right)^{\frac{1}{3}}\right]^2 = 4\pi\left(\frac{3V}{4\pi}\right)^{\frac{2}{3}}$

$= \frac{4\pi(3V)^{\frac{2}{3}}}{(4\pi)^{\frac{2}{3}}} = (3V)^{\frac{2}{3}} \times \frac{(4\pi)^1}{(4\pi)^{\frac{2}{3}}}$

$= (3V)^{\frac{2}{3}}(4\pi)^{1-\frac{2}{3}} = (4\pi)^{\frac{1}{3}}(3V)^{\frac{2}{3}}$

Question 600: A

Let each unit length be x.

Thus, $S = 6x^2$. Therefore, $x = \left(\frac{S}{6}\right)^{\frac{1}{2}}$

$V = x^3$. Thus, $V = \left[\left(\frac{S}{6}\right)^{\frac{1}{2}}\right]^3$ so $V = \left(\frac{S}{6}\right)^{\frac{3}{2}}$

Question 601: B

Multiplying the second equation by 2:

$4x + 16y = 24$.

Subtract the first equation from this to get:

$13y = 17$

So $y = \frac{17}{13}$.

Then, solve for x:

$4x + 16\left(\frac{17}{13}\right) = 24$

$4x = 24 - \frac{272}{13}$

$4x = \frac{40}{13}$

$x = \frac{10}{13}$

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Question 602: A

Multiply by the denominator to give: $(7x + 10) = (3y^2 + 2)(9x + 5)$

Partially expand brackets on right side: $(7x + 10) = 9x(3y^2 + 2) + 5(3y^2 + 2)$

Take x terms across to left side: $7x - 9x(3y^2 + 2) = 5(3y^2 + 2) - 10$

Take x outside the brackets: $x[7 - 9(3y^2 + 2)] = 5(3y^2 + 2) - 10$

Thus: $x = \frac{5(3y^2 + 2) - 10}{7 - 9(3y^2 + 2)}$

Simplify to give $x = \frac{(15y^2)}{(7 - 9(3y^2 + 2))}$

Question 603: E

$$3x\left(\frac{3x^7}{x^{\frac{1}{3}}}\right)^3 = 3x\left(\frac{3^3x^{21}}{x^{\frac{3}{3}}}\right)$$

$$= 3x\,\frac{27x^{21}}{x} = 81x^{21}$$

Question 604: D

$2x[2^{\frac{7}{14}}x^{\frac{7}{14}}] = 2x[2^{\frac{1}{2}}x^{\frac{1}{2}}]$

$= 2x(\sqrt{2}\sqrt{x}) = 2[\sqrt{x}\sqrt{x}][\sqrt{2}\sqrt{x}]$

$= 2\sqrt{2x^3}$

Question 605: A

$A = \pi r^2$, therefore $10\pi = \pi r^2$

Thus, $r = \sqrt{10}$

Therefore, the circumference is $2\pi\sqrt{10}$.

Question 606: D

$3.4 = 12 + (3 + 4) = 19$

$19.5 = 95 + (19 + 5) = 119$

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Question 607: D

$2.3 = \frac{2^3}{2} = 4$

$4.2 = \frac{4^2}{4} = 4$

Question 608: E

This is a tricky question that requires you to know how to 'complete the square':

$(x + 1.5)(x + 1.5) = x^2 + 3x + 2.25$

Thus, $(x + 1.5)^2 - 7.25 = x^2 + 3x - 5 = 0$

Therefore, $(x + 1.5)^2 = 7.25 = \frac{29}{4}$

Thus, $x + 1.5 = \sqrt{\frac{29}{4}}$

Thus $x = -\frac{3}{2} \pm \sqrt{\frac{29}{4}} = -\frac{3}{2} \pm \frac{\sqrt{29}}{2}$

Question 609: B

Whilst you definitely need to solve this graphically, it is necessary to complete the square for the first equation to allow you to draw it more easily:

$(x + 2)^2 = x^2 + 4x + 4$

Thus, $y = (x + 2)^2 + 10 = x^2 + 4x + 14$

This is now an easy curve to draw ($y = x^2$ that has moved 2 units left and 10 units up). The turning point of this quadratic is to the left and well above anything in x^3, so the only solution is the first intersection of the two curves in the upper right quadrant around (3.4, 39).

Question 610: C

By far the easiest way to solve this is to sketch them (don't waste time solving them algebraically). As soon as you've done this, it'll be very obvious that $y = 2$ and $y = 1 - x^2$ don't intersect, since the latter has its turning point at (0, 1) and zero points at $x = -1$ and 1. $y = x$ and $y = x^2$ intersect at the origin and (1, 1), and $y = 2$ runs through both.

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Question 611: B

Notice that you're not required to get the actual values – just the number's magnitude. Thus, 897653 can be approximated to 900,000 and 0.009764 to 0.01. Therefore, 900,000 x 0.01 = 9,000

Question 612: C

Multiply through by 70: 7 (7x + 3) + 10 (3x + 1) = 14 x 70

Simplify: 49x + 21 + 30x + 10 = 980

79x + 31 = 980

$x = \frac{949}{79}$

Question 613: A

Split the equilateral triangle into 2 right-angled triangles and apply Pythagoras' theorem:

$x^2 = \left(\frac{x}{2}\right)^2 + h^2$. Thus $h^2 = \frac{3}{4}x^2$

$h = \sqrt{\frac{3x^2}{4}} = \frac{\sqrt{3x^2}}{2}$

The area of a triangle = ½ x base x height = $\frac{x}{2} \times \frac{\sqrt{3x^2}}{2}$

Simplifying gives: $x\frac{\sqrt{3x^2}}{4} = x\frac{\sqrt{3}\sqrt{x^2}}{4} = \frac{x^2\sqrt{3}}{4}$

Question 614: A

This is a question testing your ability to spot 'the difference between two squares'.

Factorise to give: $3 - \frac{7x(5x - 1)(5x + 1)}{(7x)^2(5x + 1)}$

Cancel out: $3 - \frac{(5x - 1)}{7x}$

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Question 615: C

The easiest way to do this is to 'complete the square':

$(x- 5)^2 = x^2 - 10x + 25$

Thus, $(x - 5)^2 - 125 = x^2 - 10x - 100 = 0$

Therefore, $(x - 5)^2 = 125$

$x - 5 = \pm\sqrt{125} = \pm\sqrt{25}\ \sqrt{5} = \pm 5\sqrt{5}$

$x = 5 \pm 5\sqrt{5}$

Question 616: B

Factorise by completing the square:

$x^2 - 4x + 7 = (x - 2)^2 + 3$

Simplify: $(x - 2)^2 = y^3 + 2 - 3$

$x - 2 = \pm\sqrt{y^3 - 1}$ so $x = 2 \pm \sqrt{y^3 - 1}$

Question 617: D

Square both sides to give: $(3x + 2)^2 = 7x^2 + 2x + y$

Thus: $y = (3x + 2)^2 - 7x^2 - 2x = \left(9x^2 + 12x + 4\right) - 7x^2 - 2x$

$y = 2x^2 + 10x + 4$

Question 618: C

This is where looking at the options makes your life a lot easier. In all of them, opening the bracket on the right side involves making $(y \pm 1)^4$ on the left side, i.e. the answers are hinting that $(y \pm 1)^4$ is the solution to the fourth order polynomial.

Since there are negative terms in the equations (e.g. $-4y^3$), the solution has to be:

$(y - 1)^4 = y^4 - 4y^3 + 6y^2 - 4y + 1$

Therefore, $(y - 1)^4 + 1 = x^5 + 7$

Thus, $y - 1 = \left(x^5 + 6\right)^{\frac{1}{4}}$

$y = 1 + \left(x^5 + 6\right)^{1/4}$

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Question 619: A

Let the width of the television be 4x and the height of the television be 3x.

Then by Pythagoras: $(4x)^2 + (3x)^2 = 50^2$

Simplify: $25x^2 = 2500$

Thus: $x = 10$. Therefore: the screen is 30 inches by 40 inches, i.e. the area is 1,200 inches^2.

Question 620: C

Square both sides to give: $1 + \frac{3}{x^2} = (y^5 + 1)^2$

Multiply out: $\frac{3}{x^2} = (y^{10} + 2y^5 + 1) - 1$

Thus: $x^2 = \frac{3}{y^{10} + 2y^5}$

Therefore: $x = \sqrt{\frac{3}{y^{10} + 2y^5}}$

Question 621: C

The easiest way is to double the first equation and triple the second to get:

$6x - 10y = 20$ and $6x + 6y = 39$.

Subtract the first from the second to give: $16y = 19$,

Therefore, $y = \frac{19}{16}$.

Substitute back into the first equation to give $x = \frac{85}{16}$.

Question 622: C

This is fairly straightforward; the first inequality is the easier one to work with: **B** and **D** and **E** violate it, so we just need to check **A** and **C** in the second inequality.

C: $1^3 - 2^2 < 3$, but **A**: $2^3 - 1^2 > 3$

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Question 623: B

Whilst this can be done graphically, it's quicker to do algebraically (because the second equation is not as easy to sketch). Intersections occur where the curves have the same coordinates.

Thus: $x + 4 = 4x^2 + 5x + 5$

Simplify: $4x^2 + 4x + 1 = 0$

Factorise: $(2x + 1)(2x + 1) = 0$

Thus, the two graphs only intersect once at $x = -\frac{1}{2}$

Question 624: D

It's better to do this algebraically as the equations are easy to work with and you would need to sketch very accurately to get the answer. Intersections occur where the curves have the same coordinates. Thus: $x^3 = x$

$x^3 - x = 0$

Thus: $x(x^2 - 1) = 0$

Spot the 'difference between two squares': $x(x + 1)(x - 1) = 0$

Thus there are 3 intersections: at $x = 0$, 1 and -1

Question 625: E

Note that the line is the hypotenuse of a right-angled triangle with one side unit length and one side of length ½.

By Pythagoras, $\left(\frac{1}{2}\right)^2 + 1^2 = x^2$

Thus, $x^2 = \frac{1}{4} + 1 = \frac{5}{4}$

$x = \sqrt{\frac{5}{4}} = \frac{\sqrt{5}}{\sqrt{4}} = \frac{\sqrt{5}}{2}$

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Question 626: D

You could solve this question by eliminating a variable and creating simultaneous equations, but trial and error is far quicker and easier than that lengthy process. Simply substitute the given values into equation 1.

A: 2 – 15 – (-15) = 2
B: 15 + 2 – 14 = 3
C: 14 + 15 – (-2) = 31
D: -2 + 15 – 14 = -1
E: 2 – 15 – 14 = -27

Only **D** works, so through process of elimination we know this is the answer.

Question 627: D

This is one of the easier maths questions. Take 3a as a factor to give:
$3a\ (a^2 – 10a + 25) = 3a\ (a – 5)\ (a – 5) = 3a\ (a – 5)^2$

Question 628: B

Note that 12 is the Lowest Common Multiple of 3 and 4. Thus:
-3 (4x + 3y) = -3 (48) Multiply each side by -3
4 (3x + 2y) = 4 (34) Multiply each side by 4
-12x – 9y = -144

12x + 8y = 136 Add together
-y = -8
y = 8

Substitute y back in:
4x + 3y = 48
4x + 3 (8) = 48
4x + 24 = 48
4x = 24
x = 6

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Question 629: E

Don't be fooled, this is an easy question, just obey BODMAS and don't skip steps.

$$\frac{-(5^2 - 4 \times 7)^2}{-6^2 + 2 \times 7}$$

$$\frac{-(25 - 28)^2}{-36 + 14} = \frac{-(-3)^2}{-22}$$

This gives: $\frac{-(9)}{-22} = \frac{9}{22}$

Question 630: E

Since there are 26 possible letters for each of the 3 letters in the license plate, and there are 10 possible numbers (0-9) for each of the 3 numbers in the same plate, then the number of license plates would be:

(26) x (26) x (26) x (10) x (10) x (10) = 17,576,000

Question 631: B

Expand the brackets to give: $4x^2 - 12x + 9 = 0$.

Factorise: $(2x - 3)(2x - 3) = 0$.

Thus, only one solution exists, $x = 1.5$.

Note that you could also use the fact that the discriminant, $b^2-4ac=0$ to get the answer.

Question 632: C

$$= \left(x^{\frac{1}{2}}\right)^{\frac{1}{2}} \left(y^{-3}\right)^{\frac{1}{2}}$$

$$= x^{\frac{1}{4}} y^{-\frac{3}{2}} = \frac{x^{\frac{1}{4}}}{y^{\frac{3}{2}}}$$

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Question 633: A

Let x, y, and z represent the rent for the 1-bedroom, 2-bedroom, and 3-bedroom flats, respectively. We can write 3 different equations: one for the rent, one for the repairs, and the last one for the statement that the 3-bedroom unit costs twice as much as the 1-bedroom unit.

(1) $x + y + z = 1240$

(2) $0.1x + 0.2y + 0.3z = 276$

(3) $z = 2x$

Substitute $z = 2x$ in both of the two other equations to eliminate z:

(4) $x + y + 2x = 3x + y = 1240$

(5) $0.1x + 0.2y + 0.3(2x) = 0.7x + 0.2y = 276$

Multiply each side of (4) by -2:

$-2(3x + y) = -2(1240)$

Multiply each side of (5) by 10

$10(0.7x + 0.2y) = 10(276)$

Add these 2 equations:

(6) $-6x - 2y = -2480$

(7) $7x + 2y = 2760$

$x = 280$

$z = 2x$, so $z = 2(280) = 560$

$x + y + z = 1240$, so $280 + y + 560 = 1240$

$y = 400$

Thus the units' rents are £ 280, £ 400 and £ 560 per week respectively.

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Question 634: C

Following BODMAS:

$= 5\left[5\left(6^2 - 5 \times 3\right) + 400^{\frac{1}{2}}\right]^{1/3} + 7$

$= 5\ [5(36 - 15) + 20]^{\frac{1}{3}} + 7$

$= 5\ [5(21) + 20]^{\frac{1}{3}} + 7$

$= 5\ (105 + 20)^{\frac{1}{3}} + 7$

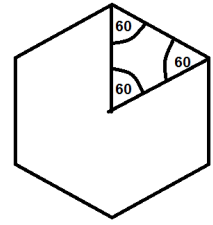
$= 5\ (125)^{\frac{1}{3}} + 7$

$= 5\ (5) + 7$

$= 25 + 7 = 32$

Question 635: B

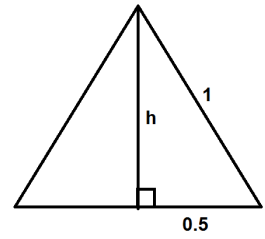
Consider a triangle formed by joining the centre to two adjacent vertices. Six similar triangles can be made around the centre – thus, the central angle is 60 degrees. Since the two lines forming the triangle are of equal length, we have 6 identical equilateral triangles in the hexagon.



Now split the triangle in half and apply Pythagoras' theorem:

$1^2 = 0.5^2 + h^2$

Thus, $h = \sqrt{\frac{3}{4}} = \frac{\sqrt{3}}{2}$



Thus, the area of the triangle is: $\frac{1}{2}bh = \frac{1}{2} \times 1 \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{4}$

Therefore, the area of the hexagon is: $\frac{\sqrt{3}}{4} \times 6 = \frac{3\sqrt{3}}{2}$

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Question 636: B

Let x be the width and x + 19 be the length.

Thus, the area of a rectangle is x (x + 19) = 780.

Therefore:

$x^2 + 19x – 780 = 0$

(x - 20) (x + 39) = 0

x – 20 = 0 or x + 39 = 0

x = 20 or x = -39

Since length can never be a negative number, we disregard x = -39 and use x = 20 instead. Thus, the width is 20 metres and the length is 39 metres.

Question 637: B

The quickest way to solve is by trial and error, substituting the provided options. However, if you're keen to do this algebraically, you can do the following:

Start by setting up the equations: Perimeter = 2L + 2W = 34

Thus: L + W = 17

Using Pythagoras: $L^2 + W^2 = 13^2$

Since L + W = 17, W = 17 - L

Therefore: $L^2 + (17 – L)^2 = 169$

$L^2 + 289 – 34L + L^2 = 169$

$2L^2 – 34L + 120 = 0$

$L^2 – 17L + 60 = 0$

(L – 5) (L – 12) = 0

Thus: L = 5 and L = 12

And: W = 12 and W = 5

Question 638: C

Multiply both sides by 8: 4 (3x - 5) + 2 (x + 5) = 8 (x +1)

Remove brackets: 12x - 20 + 2x + 10 = 8x + 8

Simplify: 14x - 10 = 8x + 8

Add 10: 14x = 8x + 18

Subtract 8x: 6x = 18

Therefore: x = 3

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Question 639: C

Recognise that 1.742 x 3 = 5.226. Now, the original equation simplifies to: = $\frac{3 \times 10^6 + 3 \times 10^5}{10^{10}}$

$= 3 \times 10^{-4} + 3 \times 10^{-5} = 3.3 \times 10^{-4}$

Question 640: A

Area = $\frac{(2 + \sqrt{2})(4 - \sqrt{2})}{2}$

$= \frac{8 - 2\sqrt{2} + 4\sqrt{2} - 2}{2}$

$= \frac{6 + 2\sqrt{2}}{2}$

$= 3 + \sqrt{2}$

Question 641: C

Square both sides: $\frac{4}{x} + 9 = (y - 2)^2$

$\frac{4}{x} = (y - 2)^2 - 9$

Cross Multiply: $\frac{x}{4} = \frac{1}{(y - 2)^2 - 9}$

$x = \frac{4}{y^2 - 4y + 4 - 9}$

Factorise: $x = \frac{4}{y^2 - 4y - 5}$

$x = \frac{4}{(y + 1)(y - 5)}$

Question 642: D

Set up the equation: 5x - 5 = 0.5 (6x + 2)

10x - 10 = 6x + 2

4x = 12

x = 3

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Question 643: C

Round numbers appropriately: $\frac{55 + (\frac{9}{4})^2}{\sqrt{900}} = \frac{55 + \frac{81}{16}}{30}$

81 rounds to 80 to give: $\frac{55 + 5}{30} = \frac{60}{30} = 2$

Question 644: E

Speed = distance/time. Hence for the faster pain impulse the speed is 1m/0.001 seconds. Hence the speed of the pain impulse is 1000 metres per second. The normal touch impulse is half this speed and so is 500 metres per second.

Question 645: A

Although it is possible to do this algebraically, by far the easiest way is via trial and error. The clue that you shouldn't attempt it algebraically is the fact that rearranging the first equation to make x or y the subject leaves you with a difficult equation to work with (e.g. $x = \sqrt{1 - y^2}$) when you try to substitute in the second.

An exceptionally good student might notice that the equations are symmetric in x and y, i.e. the solution is when x = y. Thus $2x^2 = 1$ and $2x = \sqrt{2}$ which gives $\frac{\sqrt{2}}{2}$ as the answer.

Question 646: C

If two shapes are congruent, then they are the same size and shape. Thus, congruent objects can be rotations and mirror images of each other. The two triangles in **E** are indeed congruent (SAS). Congruent objects must, by definition, have the same angles.

Question 647: B

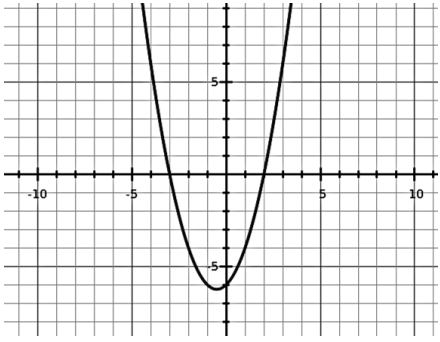
Rearrange the equation: $x^2 + x - 6 \geq 0$

Factorise: $(x + 3)(x - 2) \geq 0$

Remember that this is a quadratic inequality so requires a quick sketch to ensure you don't make a silly mistake with which way the sign is.

Thus, y = 0 when x = 2 and x = -3. y > 0 when x> 2 or x<-3.

Thus, the solution is: $x \leq -3$ and $x \geq 2$.



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Question 648: B

Using Pythagoras: $a^2 + b^2 = x^2$

Since the triangle is isosceles: a = b, so $2a^2 = x^2$

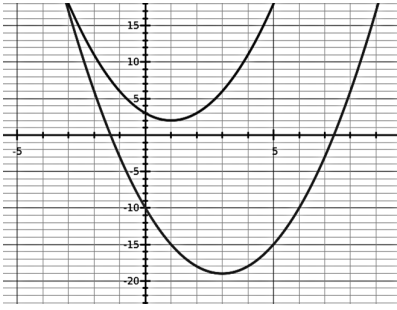
Area = $\frac{1}{2}$base x height = $\frac{1}{2}a^2$. From above, $a^2 = \frac{x^2}{2}$

Thus the area = $\frac{1}{2} \times \frac{x^2}{2} = \frac{x^2}{4}$

Question 649: A

If X and Y are doubled, the value of Q increases by 4. Halving the value of A reduces this to 2. Finally, tripling the value of B reduces this to ⅔, i.e. the value decreases by ⅓.

Question 650: C



The quickest way to do this is to sketch the curves. This requires you to factorise both equations by completing the square:

$x^2 - 2x + 3 = (x - 1)^2 + 2$

$x^2 - 6x - 10 = (x - 3)^2 - 19$

Thus, the first equation has a turning point at (1, 2) and doesn't cross the x-axis. The second equation has a turning point at (3, -19) and crosses the x-axis twice

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IMAT PRACTICE PAPERS

This book contains six unique mock papers written as a useful revision resource for you to use once you have completed all the practice questions in this book. They're also a vital warm up for the past papers, which are the closest thing to the paper you'll be taking and your best preparation.

GETTING THE MOST OUT OF MOCK PAPERS

Mock exams can prove invaluable if tackled correctly. Not only do they encourage you to start revision earlier, but they also allow you to **practice and perfect your revision technique**. They are often the best way of improving your knowledge base or reinforcing what you have learnt. Probably the best reason for attempting mock papers is to familiarise yourself with the exam conditions of the IMAT, as they are particularly tough.

Start Revision Earlier

Thirty five percent of students agree that they procrastinate to a degree that is detrimental to their exam performance. This is partly explained by the fact that they often seem a long way in the future. In the scientific literature this is well recognised; Dr. Piers Steel, an expert on the field of motivation states that *'the further away an event is, the less impact it has on your decisions'*.

Mock exams are therefore a way of giving you a target to work towards and motivate you in the run up to the real thing – every time you do one treat it as the real deal! If you do well then it's a reassuring sign; if you do poorly then it will motivate you to work harder (and earlier!).

Practice and Perfect Revision Techniques

In case you haven't realised already, revision is a skill all to itself, and can take some time to learn. For example, the most common revision techniques including **highlighting and/or re-reading are quite ineffective** ways of committing things to memory. Unless you are thinking critically about something, you are much less likely to remember it or indeed understand it.

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Mock exams, therefore, allow you to test your revision strategies as you go along. Try spacing out your revision sessions so you have time to forget what you have learnt in-between. This may sound counterintuitive, but the second time you remember it for longer. Try teaching another student what you have learnt; this forces you to structure the information in a logical way that may aid memory. Always try to question what you have learnt and appraise its validity. Not only does this aid memory, but it is also a useful skill for IMAT section 3, interviews, and beyond.

Improve your knowledge

The act of applying what you have learnt reinforces that piece of knowledge. A question may ask you to think about a relatively basic concept in a novel way (not cited in textbooks), and so deepen your understanding. Exams rarely test word for word what is in the syllabus, so when running through mock papers try to understand how the basic facts are applied and tested in the exam. As you go through the mocks or past papers, take note of your performance and see if you consistently under-perform in specific areas, thus highlighting areas for future study.

Get familiar with exam conditions

Pressure can cause all sorts of trouble for even the most brilliant students. The IMAT is a particularly time-pressured exam with high stakes – your future (without exaggerating) does depend on your result to a great extent. The real key to the IMAT is overcoming this pressure and remaining calm to allow you to think efficiently.
Mock exams are therefore an excellent opportunity to devise and perfect your own exam techniques to beat the pressure and meet the demands of the exam. **Don't treat mock exams like practice questions – it's imperative you do them under time conditions.**

> ***Remember!*** It's better that you make all the mistakes you possibly can now in mock papers and then learn from them so as not to repeat them in the past papers or the real exam.

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HOW TO USE THIS SECTION

If you have done everything this book has described so far then you should be well equipped to meet the demands of the IMAT, and therefore **the 6 mock papers in the rest of this book should ONLY be completed under exam conditions**. This means:

- Absolute silence – no TV or music
- Absolute focus – no distractions such as eating your dinner
- Strict time constraints – no pausing halfway through
- No checking the answers as you go
- Give yourself a maximum of three minutes between sections – keep the pressure up
- Complete the entire paper before marking
- Mark harshly

After completing the paper, ensure you:

- Highlight any areas of concern.
- If warranted, read up on the areas you felt you underperformed to reinforce your knowledge.
- If you inadvertently learnt anything new by muddling through a question, go and tell somebody about it to reinforce what you've discovered.

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Scoring Tables

Use these scoring tables to keep track of your results.

SECTION 1	1st Attempt	2nd Attempt	3rd Attempt
Mock A			
Mock B			
Mock C			
Mock D			
Mock E			
Mock F			
SECTION 2	1st Attempt	2nd Attempt	3rd Attempt
Mock A			
Mock B			
Mock C			
Mock D			
Mock E			
Mock F			
SECTION 3	1st Attempt	2nd Attempt	3rd Attempt
Mock A			
Mock B			
Mock C			
Mock D			
Mock E			
Mock F			
SECTION 4	1st Attempt	2nd Attempt	3rd Attempt
Mock A			
Mock B			
Mock C			
Mock D			
Mock E			
Mock F			

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Mock Paper A: Section 1

Question 1:

The Dolomite mountain range, which borders the Alps, is located in which country?

A. Italy
B. France
C. Germany
D. Denmark
E. Spain

Question 2:

The Marriage of Figaro is an opera written by which 18th century composer?

A. Beethoven
B. Mozart
C. Tchaikovsky
D. Chopin
E. Rimsky-Korsakov

Question 3:

Which Ancient empire built the city of Tenochtitlan in modern day Mexico?

A. Aztec
B. Inca
C. Babylon
D. Rome
E. Maya

Question 4:

Which Dutch artists painted *Girl with a Pearl Earring*?

A. Vincent Van Gogh
B. Johannes Vermeer
C. Sandro Botticelli
D. Pablo Picasso
E. Rembrandt

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Question 5:
The speech which begins, 'Friends, Romans, Countrymen, lend me your ears' is from which play by Shakespeare?

A. Othello
B. Romeo & Juliet
C. Anthony & Cleopatra
D. The Merchant of Venice
E. Julius Caesar

Question 6:
What ruler was crowned emperor of the Holy Roman Empire on Christmas Day of 800 AD?

A. Robert the Bruce
B. Edward I
C. Charlemagne
D. Julius Caesar
E. Charles the Bald

Question 7:
The Harlem Renaissance was a 20th Century artistic and poetic movement based in which city?

A. Paris
B. Madrid
C. New York
D. San Francisco
E. Chicago

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Question 8:
The Knights Hospitaller formerly governed which EU member state?

A. Italy
B. Malta
C. Spain
D. France
E. Cyprus

Question 9:
Which British prime minister left office after nearly 12 years in power in 1990?

A. John Major
B. Gordon Brown
C. Tony Blair
D. Harold Wilson
E. Margaret Thatcher

Question 10:
Io and Europa are both moons of which planet?

A. Jupiter
B. Saturn
C. Uranus
D. Neptune
E. Pluto

Question 11:
In 2016 the Colombian government signed a peace accord with members of which militant group?

A. FARC
B. IRA
C. Al-Qaida
D. Shining Path
E. ET

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Question 12:
The Metamorphoses is a work of Latin poetry by which author?

A. Homer
B. Dante
C. Virgil
D. Ovid
E. Plato

Question 13:
Car A has a fuel tank capacity of 30 gallons and achieves 40mpg. Car B, on the other hand, has a fuel tank capacity of 50 gallons but only achieves 30mpg. Both cars drive until they run out of fuel. If car A starts with a full tank of petrol and travels 200 miles further than car B, how full was car B's fuel tank?

A. 1/5
B. 1/4
C. 1/3
D. 1/2
E. 2/3

Question 14:
The keypad to a safe comprises the digits 1 - 9. The code itself can be of indeterminate length. The code is therefore set by choosing a reference number so that when a code is entered, the average of all the numbers entered must equal the chosen reference number.

Which of the following is true?

A. If the reference number was set greater than 9, the safe would be locked forever.
B. This safe is extremely insecure as if random digits were pressed for long enough it would average out at the correct reference number.
C. More than one number is always required to achieve the reference number.
D. All of the above are true.
E. None of the above are true.

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Question 15:
The use of antibiotics is one of the major paradoxes in modern medicine. Antibiotics themselves provide a selection pressure to drive the evolution of antibiotic resistant strains of bacteria. This is largely due to the rapid growth rate of bacterial colonies and asexual cell division. As such, a widespread initiative is in place to limit the prescription of antibiotics.

Which of the following is a fair assumption?
A. Antibiotic resistance is impossible to avoid as it is driven by evolution.
B. If bacteria reproduced at a slower rate, antibiotic resistance would not be such an issue.
C. Medicine always creates more problems than it solves.
D. In the past, antibiotics were used frivolously.
E. All of the above could be possible.

The information below relates to questions 16 – 20:
The Spaghetti Bolognese recipe below serves 10 people and each portion contains 300 kcal.

- 1kg mince
- 220g pancetta, diced
- 30g crushed garlic
- 1kg tinned tomatoes
- 300g diced onions
- 300g sliced mushrooms
- 200g grated cheese

Question 16:
What quantity of cheese is required to prepare a meal for 350 people?

A. 0.7kg
B. 7kg
C. 70kg
D. 700kg
E. 7000kg

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Question 17:
If 12 portions represent 120% of an individual's recommended calorific intake, what is that individuals recommended calorific intake?

A. 2600kcal
B. 2800kcal
C. 3000kcal
D. 3200kcal
E. 3400kcal

Question 18:
The recommended ratio of pasta to Bolognese is 4:1. If cooking for 30 people, how much pasta should be used?

A. 30.3kg
B. 36.6kg
C. 42.9kg
D. 49.2kg
E. 55.5kg

Question 19:
What is the ratio of onions to the rest of the ingredients if garlic and pancetta are ignored?

A. 1/2.05
B. 1/3.9
C. 1/6.7
D. 1/9.3
E. 1/10

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Question 20:
It takes 4 minutes to prepare the ingredients per portion, and a further 8 minutes per portion to cook. Simon has ample preparation space but is limited to cooking 8 portions at a time. What is the shortest period of time it would take him to turn all the ingredients into a meal for 25 people, assuming he didn't start cooking until all the ingredients were prepared?

A. 3 hours
B. 3 hours 40
C. 4 hours
D. 4 hours 40
E. 5 hours

Question 21:
A square sheet of paper is 20 cm long. How many times must it be folded in half before it covers an area of $12.5cm^2$?

A. 3
B. 4
C. 5
D. 6
E. 7

Question 22:
50% of an isolated population contract a new strain of resistant malaria. Only 20% are symptomatic, of which 10% are female. What percentage of the total population do symptomatic males represent?

A. 1%
B. 9%
C. 80%
D. 15%
E. 10%

END OF SECTION

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Section 2

Question 23:

Which of the following cannot be classified as organs?

1. Blood
2. Bone
3. Larynx
4. Pituitary Gland
5. Prostate
6. Skeletal Muscle
7. Skin

A. 1 and 6
B. 2 and 3
C. 5 and 7
D. 1 and 5
E. 1, 4, 5 and 6

Question 24:

An increase in aerobic respiratory rate could be associated with which of the following changes?

1. A larger percentage of water vapour in expired air
2. Increased expired CO_2
3. Increased inspired O_2
4. Perspiration
5. Vasodilatation

A. 3 only
B. 1 and 2 only
C. 1, 2 and 3 only
D. 2, 3 and 5
E. All of the above

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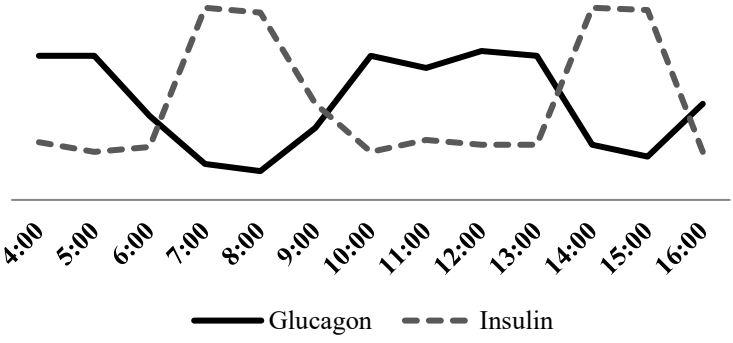
Question 25:
The nephron is to the kidney, as the _____ is to striated muscle:

A. Actin filament
B. Artery
C. Myofibril
D. Sarcomere
E. Vein

Question 26:
A diabetic patient's glucagon and insulin levels are measured over 4 hours. During this time the patient is given two large boluses of glucose. A graphical representation of this is shown below.



At which times would you expect the patient's blood glucose to be greatest?

A. 05:00 and 12:00
B. 07:00 and 14.00
C. 08:00 and 15:00
D. 10:00 and 13:00
E. 06:00, 10:00 and 16:00

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Question 27:
In addition to the A, B or O classification, blood groups can also be distinguished by the presence of Rhesus antigen (Rh). Care must be taken in blood transfusion as once blood types are mixed, a Rh -ve individual will mount an immune response against Rh +ve blood. This is particularly well exemplified in haemolytic disease of the newborn, where a Rh-ve mother carries a Rh +ve foetus.

Applying what is written here and your knowledge of the human immune system, explain why the mother's first child would be relatively safe and unaffected, yet further offspring would be at high risk.

A. The first pregnancy is always such a shock to the body that it compromises the immune system.
B. Antibodies take longer than 9 months to produce and mature to an active state.
C. First born children are immunologically privileged.
D. There is a high risk of haemorrhage to both mother and child during birth.
E. Plasma T cells require time to multiply to lethal levels.

Question 28:
At present a large effort is being made to produce tailored patient care. One of the ultimate goals of this is to be able to grow personal, genetically identical organs for those with end stage organ failure. This process will first require the harbouring of what cell type?

A. Cells from the organ that is failing
B. Haematopoietic stem cells
C. Embryonic stem cells
D. Adult stem cells
E. All of the above

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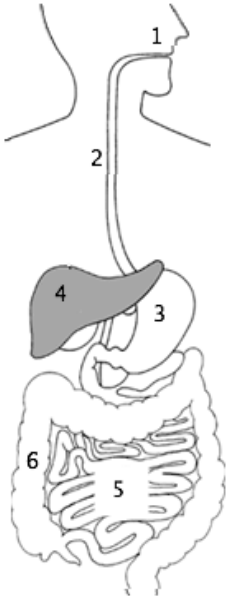
Question 29:

Which of the following statements are true?

1. Natural selection always favours organisms that are faster or stronger.
2. Genetic variation leads to different adaptations to the environment.
3. Variation is purely due to genetics.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

The following information applies to questions 30 – 31:



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Question 30:
Which of the following numbers indicate where amylase functions?

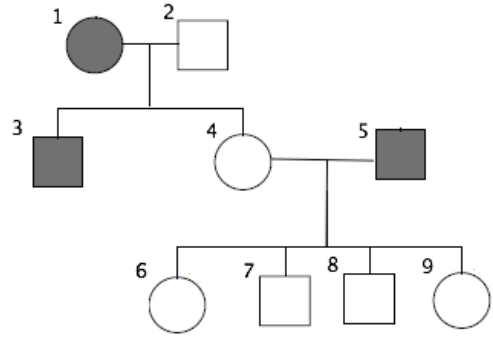
A. 1 only
B. 2 only
C. 1 and 3
D. 2 and 4
E. 1 and 5

Question 31:
In which of the following does the majority of chemical digestion occur?

A. 1
B. 2
C. 3
D. 4
E. 5

The following information applies to questions 32-33:
The diagram below shows the genetic inheritance of colour-blindness, which is inherited in a sex-linked recessive manner. X^B is the normal allele and X^b is the colour-blind allele.

Question 32:
What is the genotype of the individual marked 4?



A. $X^B X^b$
B. $X^B X^B$
C. $X^b X^b$
D. $X^B Y$
E. $X^b Y$

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Question 33:
If 8 were to reproduce with a heterozygote female, what is the probability of producing a colour-blind boy?

A. 100%
B. 75%
C. 50%
D. 25%
E. 12.5%

The following information applies to questions 34 – 35:
In pea plants, colour and stem length are inherited in an autosomal manner. The allele for yellow colour, Y, is dominant to the allele for green colour, y. Furthermore, the allele for tall stem length, T, is dominant to short stem length, t. When a pea plant of unknown genotype is crossed with a green short-stemmed pea plant, the progeny are 25% yellow + tall-stemmed plants, 25% yellow + short-stemmed plants, 25% green + tall-stemmed plants and 25% green + short-stemmed plants.

Question 34:
What is the genotype of the unknown pea plant?

A. Yytt
B. YyTt
C. YyTT
D. yyTt
E. yyTT

Question 35:
Taking both colour and height into account, how many different combinations of genotypes and phenotypes are possible?

A. 6 genotypes and 3 phenotypes
B. 8 genotypes and 3 phenotypes
C. 8 genotypes and 4 phenotypes
D. 9 genotypes and 4 phenotypes
E. 9 genotypes and 3 phenotypes

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Question 36:
Hydrogen Bicarbonate (HCO_3^-) acts as a buffer in the blood i.e. to keep the PH close to 7.

Which statement is true regarding bicarbonate?

A. It is part of the buffer system that keeps arterial blood pH as close to neutral as possible.
B. It is the conjugate base of carbonic acid.
C. If the pH of the blood drops below 7, bicarbonate will release the H^+ ion to stabilise the pH.
D. It is only released when the pH drops below 7.
E. It is bound to protein in the blood.

Question 37:
The statements below are about breathing. Which of them are incorrect?

1. The diaphragm plays no part in breathing.
2. The intercostal muscles relax during exhalation to allow the ribcage to move inwards and downwards.
3. The total pressure inside the chest decreases relative to the pressure outside the body during inhaling to draw air inside the lungs.

A. 1 only
B. 2 only
C. 3 only
D. 2 and 3
E. 1 and 3

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Question 38:
In pregnancy the foetus is supplied with blood from the mother via the umbilical cord. This cord is comprised of one vein and two arteries. The table below shows which vessel carries which type of blood in which direction.

	Vessel	Direction	Blood
1.	Vein	Mother to foetus	Oxygenated
2.	Artery	Foetus to Mother	Deoxygenated
3.	Artery	Foetus to Mother	Oxygenated
4.	Vein	Mother to Foetus	Deoxygenated

Which options are correct?

A. 1 only
B. 2 only
C. 3 only
D. 4 only
E. 1 and 2

Question 39:
What are the functions of the kidneys?

1. Ultrafiltration
2. Kill bacteria in the blood
3. Reabsorption
4. Release of waste
5. Store water
6. Produce hormones
7. Blood glucose regulation

A. 1 only
B. 3 only
C. 4 only
D. 2 and 5
E. 1, 3 and 4

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Question 40:
Mike and Vanessa are two healthy adults. They have two children. Their first child, Rory, was born with Haemophilia A, an X linked recessive disorder that causes problems with blood clotting. They have just had another baby, a girl and want to get her tested for the condition. What is the likelihood of the baby girl having the condition?

A. 0%
B. 25%
C. 50%
D. 75%
E. 33%

END OF SECTION

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Section 3

Question 41:

The pH of a solution has the greatest effect on which type of interaction?

A. Van der Waals
B. Induced dipole
C. Ionic bonding
D. Metallic interaction
E. Hydrogen bonding

Question 42:

When comparing different isotopes of the same element, which of the following may change?

1. Atomic number
2. Mass number
3. Number of electrons
4. Chemical reactivity

A. 2 only
B. 1 and 2
C. 3 only
D. 2 and 3
E. 1, 2 and 3

Question 43:

From which of the following elemental groups are you most likely to find a catalyst?

A. Alkali metals
B. d-block elements
C. Alkaline earth metals
D. Noble gases
E. Halogens

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Question 44:
1.338 kg of francium is mixed in a reaction vessel with an excess of distilled water. What volume will the hydrogen produced occupy at room temperature and pressure?

A. $20.4dm^3$
B. $36dm^3$
C. $40.8dm^3$
D. $60.12dm^3$
E. $72dm^3$

Questions 45-46 are based on the following information:
Helen is reacting potassium carbonate with nitric acid.

Question 45:
She notices that bubbles are produced in the solution, and believes the gas is hydrogen. She takes a sample of the gas. What test could she do to test for the presence of hydrogen?

A. A glowing splint we relight if put into the gas.
B. Limewater will turn cloudy if it is shaken with the gas.
C. If she holds damp blue litmus paper into the gas, the paper will turn red then white.
D. If she holds a burning splint by the end of a test tube with the gas in, she will hear a "squeaky pop".
E. A burning splint will be extinguished.

Question 46:
Is Helen right that hydrogen is produced, and if not, what gas is produced?

A. Yes
B. No – nitrogen
C. No – carbon dioxide
D. No – oxygen
E. No – methane

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Question 47:
1.2×10^{10} kg of sugar is dissolved in 4×10^{12}L of distilled water. What is the concentration in g/dL?

A. 3×10^{-2}
B. 3×10^{-1}
C. 3×10^{1}
D. 3×10^{2}
E. 3×10^{3}

Question 48:
Which of the following is not essential for the progression of an exothermic chemical reaction?

A. Presence of a catalyst
B. Increase in entropy
C. Achieving activation energy
D. Attaining an electron configuration more closely resembling that of a noble gas
E. None of the above

Question 49:
What is a common use of cationic surfactants?

A. Shampoo
B. Lubricant
C. Cosmetics
D. Detergents
E. All of the above

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Question 50:
Which of the following is the product of the reaction between propene and hydrofluoric acid (HF)?

A. $C(F)H_3$-CH_2-CH_3
B. CH_3-$C(F)H$-CH_3
C. CH_3-$C(F)H_2$-CH_2
D. CH_3-$C(F)H_2$-CH_3
E. None of the above

Question 51:
Which of the following are true about the reaction between alkenes and hydrogen halides?

1. The product formed is fully saturated.
2. The hydrogen halide binds at the alkene's saturated double bond.
3. The hydrogen halide forms ionic bonds with the alkene.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

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Question 52:
For the following reaction, which of the statements below are true?

$$N_{2(g)} + 3\ H_{2(g)} \Leftrightarrow 2\ NH_{3(g)}$$

1. Increasing pressure will cause the equilibrium to shift to the right.
2. Increasing pressure will form more ammonia gas.
3. Increasing the concentration of N_2 will create more ammonia.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1, 2 and 3

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Section 4

Question 53:

A crocodile's tail weighs 30kg. Its head weighs as much as the tail and one half of the body and legs. The body and legs together weigh as much as the tail and head combined.

What is the total weight of the crocodile?

A. 220kg
B. 240kg
C. 260kg
D. 280kg
E. 300kg

Question 54:

A body is travelling at x ms^{-1} with y J of kinetic energy. After a period of retardation the kinetic energy of the body is $1/16y$. Assuming that the mass of the body has remained constant what is its new velocity?

A. $1/196x$
B. $1/16x$
C. $1/8x$
D. $1/4x$
E. $4x$

Question 55:

Which of the following is a unit equivalent to the Volt?

A. Ω^{-1}
B. JC^{-1}
C. Ws^{-1}
D. Cs
E. WCΩ

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Question 56:

Complete the sentence below:

A voltmeter is connected in _____ and therefore has _____ resistance; whereas an ammeter is connected in _____ and has _____ resistance.

A. Parallel, zero, parallel, infinite
B. Parallel, zero, series, infinite
C. Parallel, infinite, series, zero
D. Series, zero, parallel, infinite
E. Series, infinite, parallel, zero

Question 57:

A body "A" of mass 12kg travelling at 15m/s undergoes an inelastic collision with a fixed, stationary object "B" of mass 20kg over a period of 0.5 seconds. After the collision, body A has a new velocity of 3m/s. What force must have been dissipated during the collision?

A. 288N
B. 298N
C. 308N
D. 318N
E. 328N

Question 58:

What process is illustrated here: ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + x$?

A. Thermal decomposition
B. Alpha decay
C. Beta decay
D. Gamma decay
E. Delta decay

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Question 59:

A radio dish is broadcasting messages into deep space on a 20 Hz radio frequency of wavelength 3km. With every hour how much further does the signal travel into deep space?

A. 200,000 km
B. 216,000 km
C. 232,000 km
D. 248,000 km
E. 264,000 km

Question 60:

A formula: $\sqrt[3]{\frac{z\,(x + y\,(\,l + m - n}{3}}$ is given. Would you expect this formula to calculate:

A. A length
B. An area
C. A volume
D. A volume of rotation
E. A geometric average

END OF PAPER

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Mock Paper B: Section 1

Question 1:

In 2016, the satellite *Juno* entered orbit around which planet?

A. Neptune
B. Uranus
C. Mars
D. Saturn
E. Jupiter

Question 2:

Which of these rivers is NOT located in Europe?

A. Danube
B. Seine
C. Rhine
D. Elbe
E. Volta

Question 3:

The American Declaration of Independence was signed on the 4th of July of what year?

A. 1815
B. 1789
C. 1688
D. 1776
E. 1492

Question 4:

Which major figure of 20th Century politics was released from prison in 1990?

A. Martin Luther King
B. Malcolm X
C. Nelson Mandela
D. Robert Mugabe
E. General Nasser

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Question 5:
The international agreement to reduce greenhouse gas emissions agreed by 192 countries in 1997 was signed in what city?

A. New York
B. Tokyo
C. Seoul
D. Kyoto
E. Paris

Question 6:
Marie Curie died as a result of her research into what?

A. Poisons
B. Acids
C. Fire
D. Radiation
E. Monkeys

Question 7:
Who famously said, “I disapprove of what you say, but I will defend to the death your right to say it”?

A. Rene Descartes
B. Roger Bacon
C. Voltaire
D. Baruch Spinoza
E. Desiderius Erasmus

Question 8:
Which of these countries was never part of the United Republic of Yugoslavia?

A. Bosnia
B. Serbia
C. Macedonia
D. Hungary
E. Slovenia

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Question 9:
Which of these is not a novel by Jane Austen?

A. Sense & Sensibility
B. Pride & Prejudice
C. Emma
D. Mansfield Park
E. Clarissa

Question 10:
Bastille Day is celebrated every year in France on what day?

A. 4th of July
B. 5th of November
C. 8th of August
D. 14th of July
E. 1st of December

Question 11:
The phrase "Hell is other people" is associated with which French philosopher?

A. Jean-Paul Sartre
B. Albert Camus

C. Freidrich Nietzsche
D. Jean-Jacques Rousseau
E. Rene Descartes

Question 12:
Siddhartha Gautama is the real historical name of which religious figure?

A. Jesus Christ
B. Zoroaster
C. Buddha
D. Moses
E. Guru Nanak

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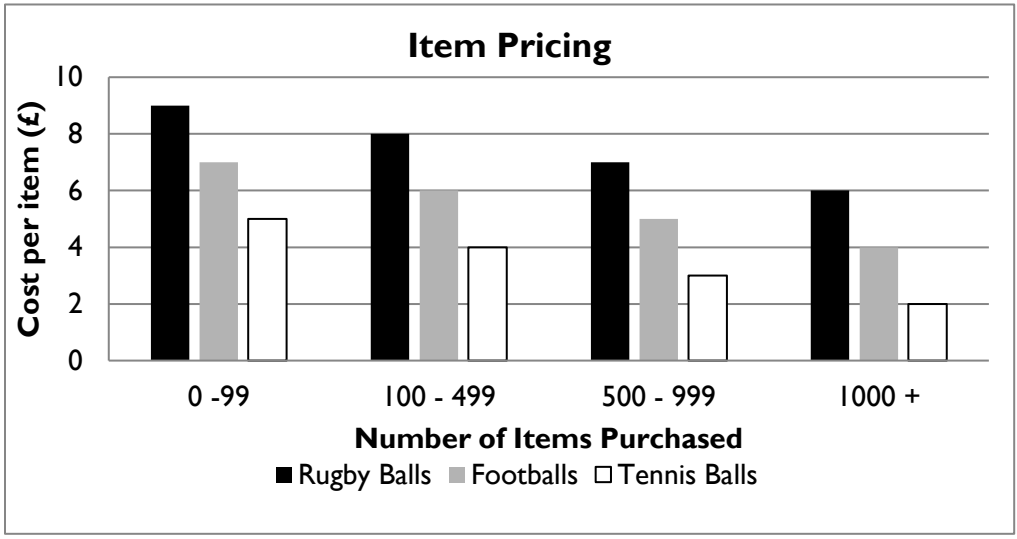
The information below relates to questions 13 – 17:



The graph above shows item pricing from a wholesaler. The wholesaler is happy to deliver, for a cost of £35 to companies or £5 to individuals. Any order over the cost of £100 qualifies for free delivery. Items are defined as how they come to the wholesaler, therefore 1 item = 2 rugby balls, 1 football, or 5 tennis balls.

Question 13:
What is the total cost to an individual purchasing 12 rugby balls and 120 tennis balls?

A. £174
B. £179
C. £208
D. £534
E. £588

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Question 14:
A private gym wishes to purchase 10 of everything, how short are they of the free delivery boundary?

A. £5.00
B. £5.01
C. £10.00
D. £10.01
E. £0.00

Question 15:
What is the greatest number of balls that can be bought by an individual with £1,000?

A. 200
B. 250
C. 500
D. 1,000
E. 1,250

Question 16:
The wholesaler sells all his products for a profit of 120%. If he sells £1,320 worth of goods at his prices, what did he spend on acquiring them himself?

A. £400
B. £600
C. £800
D. £1,100
E. £1,120

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Question 17:
If the wholesaler pays 25% tax on the amount over £12,000 pounds; how much tax does he pay when receiving an order of 2,000 of each item?

A. £2,000
B. £3,000
C. £4,000
D. £5,000
E. £6,000

Question 18:
There are four houses on a street. Lucy, Vicky, and Shannon live in adjacent houses. Shannon has a black dog named Chrissie, Lucy has a white Persian cat and Vicky has a red parrot that shouts obscenities. The owner of a four-legged pet has a blue door. Vicky has a neighbour with a red door. Either a cat or bird owner has a white door. Lucy lives opposite a green door. Vicky and Shannon are not neighbours. What colour is Lucy's door?

A. Green
B. Red
C. White
D. Blue
E. Can't tell

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Question 19:

A train driver runs a service between Cardiff and Merthyr. On average, a one-way trip takes 40 minutes to drive but he requires 5 minutes to unload passengers and a further 5 minutes to pick up new ones. As the crow flies, the distance between Cardiff and Merthyr is 22 miles.

Assuming he works an 8-hour shift with two 20-minute breaks, and when he arrives to work the first train is already loaded with passengers, how far does he travel in miles?

A. 132
B. 143
C. 154
D. 176
E. 198

Question 20:

The massive volume of traffic that travels down the M4 corridor regularly leads to congestion at times of commute morning and evening. A case is being made by local councils in congestion areas to introduce relief lanes, thus widening the motorway in an attempt to relieve the congestion. This would involve introducing either a new 2 or 4 lanes to the motorway, costing on average 1 million pound per lane per 10 miles. Many conservationist groups are concerned as this will involve the destruction of large areas of countryside either side of the motorway. They argue that the side of a motorway is a unique habitat with many rare species residing there.

The local councils argue that with many hundreds, if not thousands, of cars siding idle on the motorway pumping pollutants out into the surrounding areas, it is better for the wildlife if the congestion is eased and traffic can flow through. The councils have also remarked that if congestion is eased there would be less money needed to repair the roads from car incidents with could in theory be given to the conservationist groups as a grant.

Which of the following is assumed in this passage?

A. Wildlife living on the side of the motorway cannot be re-homed.
B. Congestion causes car incidents.
C. Relief lanes have been proven to improve traffic jams.
D. A and B
E. B and C

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Question 21:
In 4 years' time, I will be one third the age that my brother will be next year. In 20 years' time, he will be double my age. How old am I?

A. 4
B. 9
C. 15
D. 17
E. 23

Question 22:
A television is delivered in a box that has volume 60% larger than that of the television. The television is 150 cm x 100 cm x 10 cm. How much surplus volume is there?

A. $0.09m^2$
B. $0.9\ m^2$
C. $9\ m^2$
D. $90\ m^2$
E. $900\ m^2$

END OF SECTION

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Section 2

Question 23:

GLUT2 is an essential, ATP independent, mediator in the liver's uptake of plasma glucose. This is an example of:

A. Active transport
B. Diffusion
C. Exocytosis
D. Facilitated Diffusion
E. Osmosis

Question 24:

Which of the following cell types will have the greatest flux along endocytotic pathways?

A. Kidney cells
B. Liver cells
C. Nerve cells
D. Red blood cells
E. White blood cell

Question 25:

Compared to the Krebs cycle, the Calvin cycle demonstrates which of the following differences?

A. CO_2 as a substrate rather than a product
B. Utilisation of different electron transporters
C. Net loss of ATP
D. None of the above
E. All of the above

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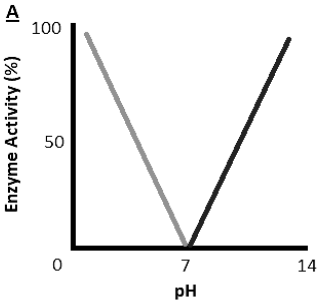
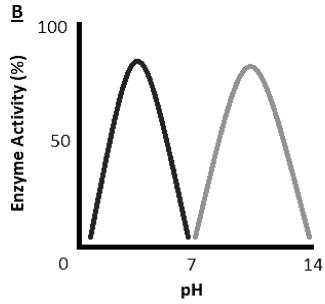
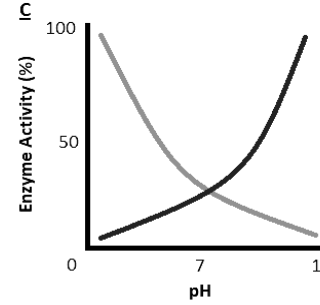
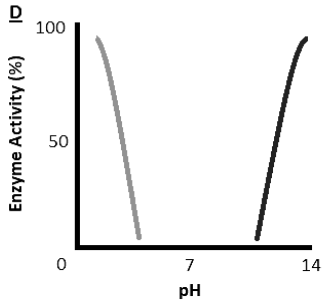
Question 26:

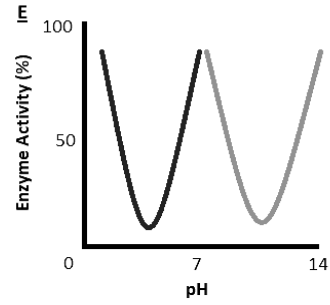
Pepsin and trypsin are both digestive enzymes. Pepsin acts in the stomach whereas trypsin is secreted by the pancreas. Which graph below (trypsin in black and pepsin in grey) would most accurately demonstrate their relative activity against pH?











Question 27:

MRSA is an example of:

A. Natural selection
B. Genetic engineering
C. Sexual reproduction
D. Lamarckism
E. Co-dominance

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Question 28:
Bacteria invade the body and produce toxins that kill cells.

What are some examples of components of the innate immune system?

1. Mucus lining the airways
2. Heat produced by the body
3. Skin
4. Antibodies produced by the immune system
5. Toxins produced by the body
6. Hydrochloric acid in the stomach

A. 1 only
B. 2 and 3
C. 1, 2, 3 and 6
D. 4, 5 and 6
E. 2 and 4

Question 29:
Which of the following is true with regards to osmosis?
A. It does not require a concentration gradient.
B. It can apply to any substance, not just water.
C. It is the movement of water across a partially permeable membrane.
D. It is an active process.
E. Transporters move water molecules across the membrane of cells.

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Question 30:
The carbon cycle is the cycle regarding the intake and release of carbon by organisms. Which of these statements are true?

A. Plants release carbon via photosynthesis and take nutrients from the soil, which have come from decayed organisms.
B. Animals give off carbon via respiration, waste, eating and death.
C. The CO_2 in the air comes from burning of plant/animal products and respiration from living organisms only.
D. Trees do not store any carbon as they give it all off as carbon dioxide.
E. Plants can give off carbon in two ways: respiration, and death.

Question 31:
Enzymes are thought to work by two mechanisms – lock and key or the induced fit theory. The Lock and Key theory states that the active site of an enzyme is already perfectly shaped for the substrate, whereas the induced fit theory states that the enzyme's active site moulds itself around the substrate's shape. Which of these statements is true?

A. The induced fit theory allows multiple, different types of substrates to be acted on by one enzyme.
B. The induced fit theory allows multiple, different types of enzymes to work on the same substrate.
C. The lock and key theory does not allow space for catatonic reactions (breaking the substrate up).
D. Enzymes are substrate specific.
E. Enzymes can act on any substrate, just some substrates are more strongly attracted to the active site.

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Question 32:
Which of the following statements about the Krebs cycle are correct?

1. Three molecules of reduced NAD and one molecule of reduced FAD are produced each turn.
2. Citric acid is regenerated to be used in the next cycle.
3. ATP can be produced by substrate-level phosphorylation.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 33:
Which of the following statements about the light-dependent reaction are correct?

1. Cyclic phosphorylation uses photosystems I and II.
2. Non-cyclic phosphorylation produces ATP, NADPH and oxygen.
3. Water is required for both cyclic and non-cyclic photophosphorylation.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

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Question 34:
Which of the following statements about the Calvin cycle are correct?

1. RUBISCO is a co-enzyme.
2. It requires 6 turns of the Calvin cycle to make 1 glucose molecule.
3. Most G3P molecules are used to regenerate RuBP.

A. 1 only
B. 2 only
C. 2 and 3
D. 1 and 3
E. 1, 2 and 3

Question 35:
Which of the following statements about action potentials are correct?

1. Depolarisation is driven by an influx of sodium ions.
2. Hyperpolarisation makes action potentials unidirectional.
3. The speed of an action potential depends on the temperature and the diameter of the axon.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1, 2 and 3

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Question 36:
A patient has been diagnosed with type 1 diabetes. Which statements about hormonal control of glucose are correct?

1. Insulin injections need to be closely monitored to prevent hypoglycaemia.
2. Adrenaline increases the storage of glucose as glycogen.
3. Glucagon is released from α-cells of the pancreas in response to a fall in blood glucose.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 37:
Which of the following statements about the cell membrane is correct?

1. The plasma membrane is primarily made up of triglycerides.
2. Cholesterol is an important structural protein for maintaining membrane fluidity.
3. Small, hydrophobic molecules can diffuse freely through the membrane.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Questions 38-40 are based on the following information:
Mr. Anderson is a 24-year old man with Haemophilia B, a disorder that causes excessive bleeding. He recently married his wife, and they want to have children. However, he knows that his condition has an X-linked recessive mode of inheritance and is worried about passing it on to his child. He mentions this concern at his next regular check-up.

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Question 38:
Would it be possible, under any circumstance, for Mr. Anderson to have an affected child?
A. Yes – there is a 50% chance of his sons being affected.
B. No – a male cannot pass on an X-linked condition to their child.
C. Yes – if his wife is a carrier.
D. No – he will not be able to have children.
E. Yes – there is a 50% a daughter will be affected.

Question 39:
Looking through Mr. Anderson's family history, you see that he has five siblings. His father, two brothers and one sister are also affected by the disease. If his parents were to have another child, what is the probability that they would have haemophilia B?

A. 0%
B. 25%
C. 33%
D. 50%
E. 100%

Question 40:
Before the age of modern medicine, many people with Haemophilia B died at a young age, because their body could not stop even a small wound from bleeding. This means the disorder is rare in the general population. What is this an example of?

A. Darwinism
B. Lamarckism
C. Sympatric speciation
D. Allopatric speciation
E. Artificial selection

END OF SECTION

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Section 3

Question 41:

The molecular weight of glucose is 180 g/mol. 5.76Kg of glucose is split evenly between two cell cultures under anaerobic conditions. One cell culture is taken from human cardiac muscle, whilst the other is a yeast culture. What will be the difference (in moles) between the amount of CO_2 produced between the two cultures?

A. 0 mol
B. 4 mol
C. 8 mol
D. 12 mol
E. 16 mol

Question 42:

What is the electron configuration of magnesium in $MgCl_2$?

A. 2,8
B. 2,8,2
C. 2,8,4
D. 2,8,8
E. 2,8,8,8

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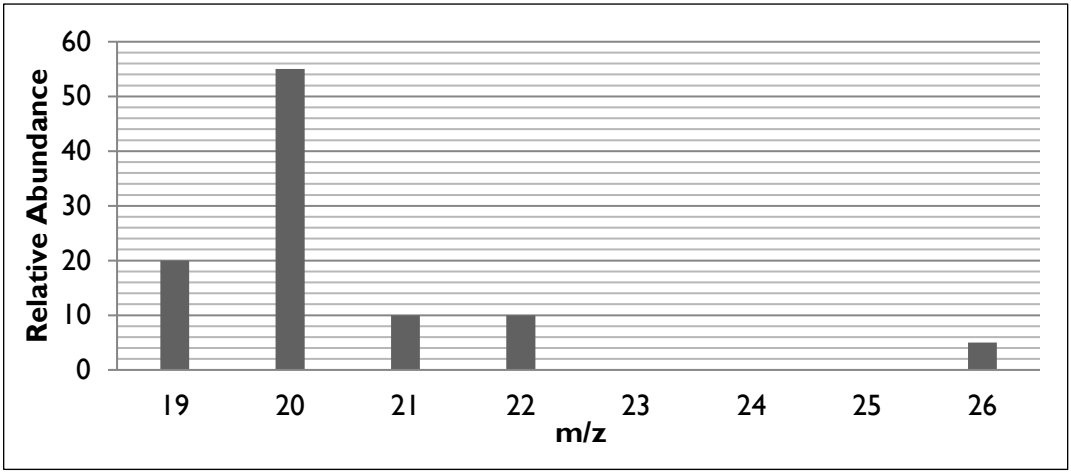
Question 43:
A calcium sample is run in a mass spectrometer. It is later discovered that the sample was contaminated with the most abundant isotope of chromium. A section of the trace is shown below. What was the actual abundance of the most common calcium isotope?



A. 1/9
B. 6/17
C. 1/2
D. 11/19
E. 17/19

Question 44:
A warehouse receives 15 tonnes of arsenic in bulk. Assuming that the sample is at least 80% pure, what is the minimum amount, in moles, of arsenic that they have obtained? A_r (As) = 75

A. 1.6×10^5
B. 2×10^5
C. 1.6×10^6
D. 2×10^6
E. 1.6×10^7

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Question 45:
A sample of silicon is run in a mass spectrometer. The resultant trace shows m/z peaks at 26 and 30 with relative abundance 60% and 30% respectively. What other isotope of silicon must have been in the sample to give an average atomic mass of 28?

A. 28
B. 30
C. 32
D. 34
E. 36

Question 46:
72.9 g of pure magnesium ribbon is mixed in a reaction vessel with the equivalent of 54 g of steam. The ensuing reaction produces 72 dm^3 of hydrogen. Which of the following statements is true?

A. This is a complete reaction.
B. This is a partial reaction.
C. There is an excess of steam.
D. There is an excess of magnesium.
E. Magnesium hydroxide is a product.

Question 47:
Which species is the reducing agent in: $3Cu^{2+} + 3S^{2-} + 8H^+ + 8NO_3^- \rightarrow 3Cu^{2+} + 3SO_4^{2-} + 8NO + 4H_2O$

A. Cu^{2+}
B. S^{2-}
C. H^+
D. NO_3^-
E. H_2O

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Question 48:
Which of the following is not true of alkanes?

A. The general formula is C_nH2_{n+2}.
B. They are saturated.
C. They are reactive.
D. They produce only CO_2 and water when burnt in an excess of oxygen.
E. None of the above.

Question 49:
Which of the following statements are true about the electrolysis of brine?

1. It describes the reduction of 2 chloride ions to Cl_2.
2. The amount of NaOH produced increases in proportion with the amount of NaCl present in solution, provided there is enough H_2 present to dissolve the NaCl.
3. The redox reaction of the electrolysis of brine results in the production of dissolved NaOH, which is a strong acid.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

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Question 50:
When sodium and chlorine react to form salt, which of the following best represents the bonding and electron configurations of the products and reactants?

	Sodium (s)		Chlorine (g)		Salt (s)	
	Intra-element bond	Element electron configuration	Intra-element bond	Element electron configuration	Compound bond	Compound electron configuration
A	Ionic	2, 8, 1	Covalent	2, 8, 8, 1	Ionic	2, 8, 1 : 2, 8, 8, 1
B	Metallic	2, 7	Covalent	2, 8, 1	Ionic	2, 8 : 2, 8
C	Covalent	2, 8, 2	Ionic	2, 8, 8	Covalent	2, 8 : 2, 8, 8
D	Ionic	2, 7	Ionic	2, 8, 8, 7	Covalent	2, 7 : 2, 8, 8, 7
E	Metallic	2, 8, 1	Covalent	2, 8, 7	Ionic	2, 8 : 2, 8, 8

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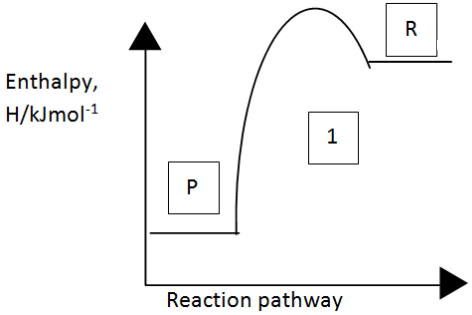
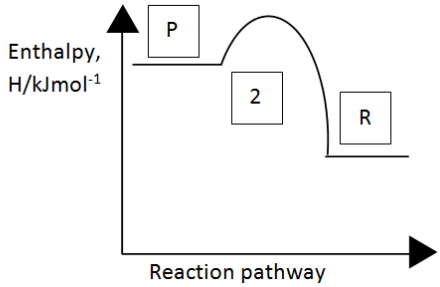
Question 51:





The two graphs shown above are enthalpy profile diagrams. Which best describes an endothermic reaction?

	Graph	ΔH	Heat energy	Stability of reactants
A	1	Negative	Absorbed from surroundings	P is more stable than R
B	2	Negative	Released to surroundings	R is more stable than P
C	1	Positive	Absorbed from surroundings	P is more stable than R
D	2	Positive	Absorbed from surroundings	R is more stable than P

Question 52:

Pyrite, also known as Fool's Gold, is an ore of iron containing sulphur in the form of iron (II) disulphide, FeS_2. By mass 75% of this ore is FeS_2.

Calculate the maximum mass of iron that can be extracted from 480kg of ore.

[A_r: Fe = 55; S = 32]165 kg

A. 200kg
B. 360.5kg
C. 118kg
D. 120.2kg

END OF SECTION

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Section 4

Question 53:

A rubber balloon is inflated and rubbed against a sample of animal fur for a period of 15 seconds. At the end of this process the balloon is carrying a charge of -5 coulombs. What magnitude of current must have been induced during the process of rubbing the balloon against the animal fur, and in which direction was it flowing?

A. 0.33A into the balloon
B. 0.33A into the fur
C. 0.33A in no net direction
D. 75A into the balloon
E. 75A into the fur

Question 54:

Which of the following is a unit equivalent to the Amp?

A. VΩ
B. (WV)/s
C. CΩ
D. $(Js^{-1})/V$
E. Cs

Question 55:

The output of a step-down transformer is measured at 24V and 10A. Given that the transformer is 80% efficient, what must the initial power input have been?

A. 240W
B. 260W
C. 280W
D. 300W
E. 320W

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Question 56:
An electric winch system hoists a mass of 20kg 30 metres into the air over a period of 20 seconds. What is the power output of the winch, assuming the system is 100% efficient?

A. 100W
B. 200W
C. 300W
D. 400W
E. 500W

Question 57:
6×10^{10} atoms of a radioactive substance remain. The activity of the substance is quantified as 3.6×10^{9}. What is the decay constant of this material?

A. 0.00006
B. 0.0006
C. 0.006
D. 0.06
E. 0.6

Question 58:
An 80W filament bulb draws 0.5A of household electricity. What is the efficiency of the bulb?

A. 25%
B. 33%
C. 50%
D. 66%
E. 75%

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Question 59:
An investment of £500 is made in a compound interest account. At the end of 3 years the balance reads £1687.50. What is the interest rate?

A. 20%
B. 35%
C. 50%
D. 65%
E. 80%

Question 60:
Which of the following statements about sound waves are correct?

1. The range of human hearing is 20 Hz – 200000 Hz.
2. Sound waves are longitudinal waves.
3. Echoes are caused by the refraction of sound.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1, 2 and 3

END OF PAPER

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Mock Paper C: Section 1

Question 1:
Which US president was impeached in 1974?

A. Lyndon B Johnson
B. Richard Nixon
C. Gerald Ford
D. George Bush
E. Jimmy Carter

Question 2:
Which painter painted the Sistine chapel?

A. Leonardo Da Vinci
B. Michelangelo
C. Botticelli
D. Rembrandt
E. Gustav Klimt

Question 3:
The world's newest country succeeded in 2011, which is it?

A. South Sudan
B. Kosovo
C. Serbia
D. Norway
E. Fiji

Question 4:
Florence Nightingale first practiced nursing in which conflict?

A. WWI
B. WWII
C. The Crimean War
D. The Napoleonic wars
E. The Boer War

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Question 5:
Which of these writers was NOT a member of the Bloomsbury group?

A. Virginia Woolf
B. Lytton Strachey
C. E.M. Forster
D. John Maynard Keynes
E. Daniel Defoe

Question 6:
Which migratory bird has the largest known wingspan of up to 12 ft?

A. Flamingo
B. Canada Goose
C. Albatross
D. Great Blue Heron
E. American White Pelican

Question 7:
Which of these is not a real historical economic bubble?

A. The South Sea Bubble
B. The Tulip Bubble
C. The Housing Bubble
D. The Dot com Bubble
E. The Beer Bubble

Question 8:
Which piece of music was made to commemorate the Russian victory over Napoleon?

A. Holst's *Jupiter*
B. Tchaikovsky *1812 Overture*
C. Stravinsky's *Rites of Spring*
D. Handel's *Water Music*
E. Shostakovich's *Stalingrad Symphony*

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Question 9:
In ancient Rome, the so-called first triumvirate was made up of Julius Caesar, Crassus and who?

A. Marc Anthony
B. Cleopatra
C. Cicero
D. Pompey Magnus
E. Marcus Aurelius

Question 10:
Albert Einstein, Robert J. Oppenheimer and Ernest Lawrence were all scientists who worked on what together during WWII?

A. The atomic bomb
B. Penicillin
C. The V-2 bomb
D. Radar
E. The helicopter

Question 11:
On 9/11, planes crashed into the World Trade Center in New York and what other building?

A. The Pentagon
B. The White house

C. The Guggenheim
D. The Rockefeller Centre
E. The Empire State building

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Question 12:
Our Sun is what kind of star?

A. Red dwarf
B. White dwarf
C. Red giant
D. Blue giant
E. Yellow dwarf

Question 13:
Until the twentieth century, the whole purpose of art was to create beautiful, flawless works. Artists attained a level of skill and craft that took decades to perfect and could not be mirrored by those who had not taken great pains to master it. The serenity and beauty produced from movements such as impressionism has however culminated in repulsive and horrific displays of rotting carcasses designed to provoke an emotional response rather than admiration. These works cannot be described as beautiful by either the public or art critics. While these works may be engaging on an intellectual or academic level, they no longer constitute art.

Which of the following is an assumption of the above argument?
A. Beauty is a defining property of art.
B. All modern art is ugly.
C. Twenty first century artists do not study for decades.
D. The impressionist movement created beautiful works of art.
E. Some modern art provokes an emotional response.

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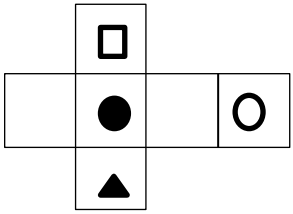
Question 14:

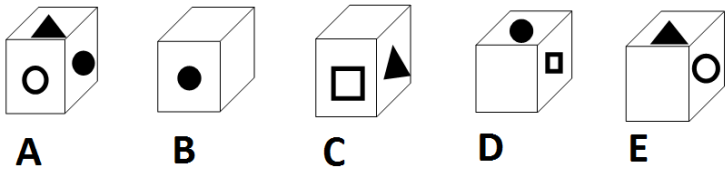
The cost of sunglasses is reduced over the bank holiday weekend. On Saturday, the price of the sunglasses on Friday is reduced by 10%. On Sunday, the price of the sunglasses on Saturday is reduced by 10%. On Monday, the price of the sunglasses on Sunday is reduced by a further 10%. What percentage of the price on Friday is the price of the sunglasses on Monday?

A. 55.12%
B. 59.10%
C. 63.80%
D. 70.34%
E. 72.9%

Question 15:

When folded, which box can be made from the net shown below?





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Questions 16-18 refer to the following information:

BMI = weight (kg ÷ heigh t^2 (m^2

BMR = Basal metabolic rate

Men	BMR = (10 x weight in kg) + (6.25 x height in cm) – (5 x age in yea
Women	BMR = (10 x weight in kg) + (6.25 x height in cm) – (5 x age in yea

Recommended Intake:

Amount of Exercise	Daily Kilocalories required
Little to no exercise	BMR x 1.2
Light exercise 1-3 days per week	BMR x 1.375
Moderate exercise 3-5 days per week	BMR x 1.55
Heavy exercise 6-7 days per week	BMR x 1.725
Very heavy exercise twice per day	BMR x 1.9

Question 16:

A child weighs 35 kg and is 120 cm tall. What is the BMI of the child to the nearest two decimal places?

A. 0.0024
B. 24.28
C. 24.31
D. 42.01
E. 42.33

Question 17:

What is the BMR of a 32-year-old woman weighing 80 kg and measuring 1.7 m in height?

A. 643.7 kcal
B. 1537 kcal
C. 1541.5 kcal
D. 1707.5 kcal
E. 2707.5 kcal

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Question 18:
What is the recommended intake of a 45-year-old man weighing 80 kg and measuring 1.7 m in height who does little to no exercise each week?

A. 1642.5 kcal
B. 1771.8 kcal
C. 1851 kcal
D. 1971 kcal
E. 2712.5 kcal

Question 19:
Putting the digit 7 on the right-hand side of a two-digit number causes the number to increase by 565. What is the value of the two-digit number?

A. 27
B. 52
C. 62
D. 66
E. 627

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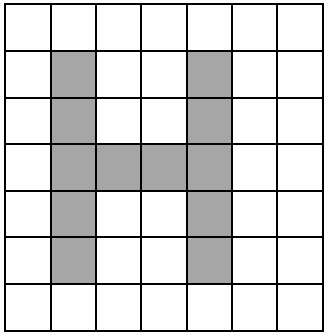
Question 20:
The grid is comprised of 49 squares. The shape's area is 588cm^2. What is its perimeter in cm?



A. 26
B. 49
C. 84
D. 126
E. 182

Question 21:
Adam, Beth and Charlie are going on holiday together. A single room costs £60 per night, a double room costs £105 per night and a four-person room costs £215 per night. It is possible to opt out from the cleaning service and to pay £12 less each night per room.

What is the minimum amount the three friends could pay for a three-night stay at the hotel?

A. £122
B. £144
C. £203
D. £423
E. £432

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Question 22:

18 years ago, A was 25 years younger than B is now. In 21 years' time, A will be 28 years older than B was 14 years ago. How old is A now, if A is $\frac{5}{6}$ B?

A. 27
B. 28
C. 35
D. 42
E. 46

END OF SECTION

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Section 2

Question 23:

Which of the following statements regarding enzymes are correct?

1. Enzymes are denatured at high temperatures or extreme pH values.
2. Amylase is produced in the salivary glands only and converts starch to sugars.
3. Lipases catalyse the breakdown of oils and fats into glycerol and fatty acids. This takes place in the small intestine.
4. Bile is stored in the pancreas and travels down the bile duct to neutralise stomach acid.
5. Isomerase can be used to convert glucose into fructose for use in slimming products.

A. 1 and 3
B. 1, 3 and 4
C. 1, 3 and 5
D. 2 and 4
E. 3 and 5

Question 24:

Which of the following describes the role of the colon?

A. Food is combined with bile and digestive enzymes.
B. Storage of faeces.
C. Reabsorption of water.
D. Faeces leave the alimentary canal.
E. Any digested food is absorbed into the lymph and blood.

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Question 25:
Which of the following are true?

1. A nerve impulse is transmitted along the nerve axon as an electrical impulse and across the synapse by diffusion of chemical neurotransmitters.
2. Drugs that block synaptic transmission can cause complete paralysis.
3. The fatty sheath around the axon slows the speed at which nerve impulses are transmitted.
4. The peripheral nervous system includes the brain and spinal cord.
5. A reflex arc bypasses the brain and enables a fast, autonomic response.

A. 1 and 2
B. 1, 2 and 3
C. 1, 2 and 5
D. 2, 4 and 5
E. 3, 4 and 5

Question 26:
Which of the following statements regarding the circulatory system are correct?

1. The pulmonary artery carries oxygenated blood from the right ventricle to the lungs.
2. The aorta has a high content of elastic tissue and carries oxygenated blood from the left ventricle around the body.
3. The mitral valve is between the pulmonary vein and the left atrium.
4. The vena cava carries deoxygenated blood from the body to the right atrium.

A. 1 and 3
B. 1 and 2
C. 2 only
D. 2 and 4
E. 3 only

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Question 27:
Tongue-rolling is controlled by the dominant allele T, while non-rolling is controlled by the recessive allele, t. Red-green colour blindness is controlled by a sex-linked gene on the X chromosome. Normal colour vision is controlled by dominant allele B, while red-green colour blindness is controlled by the recessive allele, b. The mother of a family is colour blind and heterozygous for tongue-rolling, while the father has normal colour vision and is a non-roller.

Which of the following statements are correct?

1. More males than females in a population are red-green colour blind.
2. 50% of children will be non-rollers.
3. All the male children will be colour-blind.

A. 1 and 2
B. 1, 2 and 3
C. 2 only
D. 2 and 3
E. 3 only

Question 28:
Which of the following are true?

1. Lightning, as well as nitrogen-fixing bacteria, converts nitrogen gas to nitrate compounds.
2. Decomposers return nitrogen to the soil as ammonia.
3. The shells of marine animals contain calcium carbonate, which is derived from dietary carbon.
4. Nitrogen is used to make the amino acids found in proteins.

A. 1 only
B. 1 and 2
C. 2 and 3
D. 2, 3 and 4
E. All

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Question 29:
Which of these statements about protein synthesis are correct?

1. RNA polymerase catalyses the formation of the phosphodiester bonds between the nucleotides.
2. Exons are transcribed, but not translated.
3. It occurs in the Golgi apparatus.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. None

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Question 30:
Which of the following scenarios could lead to sympatric speciation?
A. In prehistoric Europe, a population of dinosaurs was separated when Britain broke away from the mainland.
B. In 19th century Europe, a population of mosquitos entered the new London Underground tunnel system and never re-emerged.
C. In North America, there is a large population of owls that lived in the same location. Some of the group moved to live near a nearby lake, where they could prey on the fish and frogs living there. The others stayed in the woods, eating the small mice and voles living on the ground.
D. In a population of bats in Indonesia, a few individuals communicated in a much higher frequency of sound than the others.
E. In the Pacific Ocean, some members of population of eels found and moved to an area of the sea floor at a shallower depth that was densely populated with crabs and octopuses, its main prey.

Question 31:
Which of the following statements about the menstrual cycle is true?
A. The concentration of LH is highest during ovulation.
B. Menstruation occurs during the luteal phase.
C. FSH and progesterone are released from the pituitary gland.
D. Rising levels of FSH and LH cause a decrease in progesterone production.
E. Oestrogen and FSH stimulate follicle development.

Question 32:
In a healthy person, in which part of the nephron is glucose reabsorbed?

A. Bowman's capsule
B. Glomerulus
C. Proximal convoluted tubule
D. Distal convoluted tubule
E. Collecting duct

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Question 33:
Which of the following statements about anaerobic respiration are correct?

1. In humans, the two 4-carbon molecules produced are converted into lactic acid.
2. For every glucose molecule used, there is a net gain of 2 ATP molecules.
3. The first step in the process is the conversion of glucose into glucose 6-phosphate.

A. 1 and 2
B. 2 and 3
C. 1 and 3
D. 1, 2 and 3
E. None

Question 34:
Which statement best describes the appearance of a cell in the prophase stage of mitosis?

A. The chromosomes are decondensed and surrounded by a nuclear membrane.
B. The chromosomes are densely compacted, and the centrioles have moved to opposite poles of the cell and are starting to send out their spindles.
C. The chromosomes have separated at the centromere into sister chromatids and are being pulled to opposite ends of the cell.
D. The cell is starting to split down the middle into two daughter cells.
E. The chromosomes are attached to the spindles and are lined up along the middle of the cell.

Question 35:
Andrew was born with Klinefelter syndrome, a condition where a male is born with an extra X chromosome. What is his karyotype?

A. 46,XXY
B. 47,XY
C. 23,XXY
D. 23,XY
E. 47,XXY

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Question 36:
In the Manx breed of cats, there is a mutation that can cause a shortened tail (if heterozygous) or missing tail (if homozygous). The mutation has an autosomal recessive mode of inheritance. However, cats that are homozygous for the mutated allele do not survive to birth.

Two cats that are heterozygous for the mutation are bred and have one kitten. What is the probability that their offspring does not carry the mutated allele?

A. 0%
B. 25%
C. 33%
D. 50%
E. 75%

Question 37:
Which of the following statements about cardiovascular disease are correct?

1. Hypertension is dangerous because it increases the risk of heart attacks and thins the walls of the ventricles.
2. Lifestyle changes, though widely encouraged, rarely cause significant improvements in cardiovascular health.
3. Statins improve cardiovascular health by reducing blood pressure.

A. 1, 2 and 3
B. 3 only
C. 2 and 3
D. 1 only
E. None

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Question 38:
Which of the following pairs, matching a specific pathogen to its type, is incorrect?

A. HIV - virus
B. Malaria – protist
C. Salmonella – bacteria
D. E.coli – virus
E. Influenza - virus

Question 39:
Which of the following cells can pluripotent stem cells not become?

A. Sperm cells
B. Placental epithelial cells
C. Red blood cells
D. Neurons
E. Cardiac muscle cells

Question 40:
Which of the following systems are not examples of negative feedback?

1. Oxytocin release in labour in response to the baby's head pressing on the mother's cervix.
2. LH release from the pituitary gland during the menstrual cycle.
3. The release of thyroxine from the thyroid gland.
4. A follicle in the ovary releasing oestrogen to stimulate LH and FSH secretion.

A. 1 and 4
B. 1 only
C. 2 and 3
D. 3 only
E. 1, 2 and 4

END OF SECTION

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Section 3

Question 41:

Which of the following statements are true regarding the transition elements?

1. Iron (II) compounds are light green.
2. Transition elements are neither malleable nor ductile.
3. Transition metal carbonates may undergo thermal decomposition.
4. Transition metal hydroxides are soluble in water.
5. When Cu^{2+} ions are mixed with sodium hydroxide solution, a blue precipitate is formed.

A. 1 and 2
B. 1 and 3
C. 1, 3 and 5
D. 3 and 5
E. 5 only

Question 42:

What is the value of **C** when the equation is balanced? (Ph = phenyl group)

$5PhCH_3 + \underline{A}KMnO_4 + 9H_2SO_4 \rightarrow 5PhCOOH + \underline{B}K_2SO_4 + \underline{C}MnSO_4 + 14H_2O$

A. 3
B. 4
C. 5
D. 6
E. 7

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Question 43:
What is the mass in grams of calcium chloride, $CaCl_2$, in $25cm^3$ of a solution with a concentration of 0.1 mol L^{-1}? (A_r of Ca is 40 and A_r of Cl is 35)

A. 0.28g
B. 0.46g
C. 0.48g
D. 0.72g
E. 1.28g

Question 44:
16.4g of nitrobenzene is produced from 13g of benzene in excess nitric acid:

$$C_6H_6 + HNO_3 \rightarrow C_6H_5NO_2 + H_2O$$

What is the percentage yield of nitrobenzene ($C_6H_5NO_2$)?

A. 65%
B. 67%
C. 72%
D. 78%
E. 80%

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Question 45:
Which of the following statements are false?

1. Simple molecules do not conduct electricity because there are no free electrons and there is no overall charge.
2. The carbon and silicon atoms in silica are arranged in a giant lattice structure and it has a very high melting point.
3. Ionic compounds do not conduct electricity when dissolved in water or when melted because the ions are too far apart.
4. Alloys are harder than pure metals.

A. 1 and 2
B. 1, 2 and 4
C. 1, 2, 3 and 4
D. 2 and 4
E. 3 only

Question 46:
A sample of a compound with an M_r of 120 contains 12 g of carbon, 2 g of hydrogen and 16 g of oxygen. What is the molecular formula of the compound?

A. CH_2O
B. $C_2H_4O_2$
C. C_4H_2O
D. $C_4H_8O_4$
E. $C_8H_{16}O_8$

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Question 47:
The following points refer to the halogens:

1. Iodine is a grey solid and can be used to sterilise wounds. It forms a purple vapour when warmed.
2. The melting and boiling points increase as you go up the group.
3. Fluorine is very dangerous and reacts instantly with iron wool, whereas iodine must be strongly heated, as well as the iron wool, for a reaction, albeit slow, to occur.
4. When bromine is added to sodium chloride, the bromine displaces chlorine from sodium chloride.
5. The hydrogen atom and chlorine atom in hydrogen chloride are joined by a covalent bond.

Which of the above statements are false?

A. 1, 3 and 5
B. 1, 2 and 3
C. 2 and 4
D. 3 only
E. 3, 4 and 5

Question 48:
$X_{(s)} + FeSO_{4(aq)} \rightarrow XSO_{4(aq)} + Fe_{(S)}$

Which metal can be correctly be substituted in X's place?

A. Tin (Sn)
B. Zinc (Zn)
C. Lead (Pb)
D. Silver (Ag)
E. Copper (Cu)

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Question 49:
Leon has been given a sample of an unknown solution by his chemistry teacher and is asked to identify it. He makes the following observations:

- When aqueous silver nitrate is added, a cream precipitate forms.
- He sees a lilac flame when conducting a flame test.

What compound has Leon been given?

A. Potassium bromide
B. Potassium sulfate
C. Calcium sulfate
D. Sodium bromide
E. Sodium chloride

Question 50:
The element shown to the right is Germanium.
How many electrons does one atom of Germanium have?

73
Ge
32

A. 32
B. 73
C. 36
D. 41
E. 4

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Question 51:

For the following reaction, which of the statements is true?

$$CH_{4(g)} + 2O_{2(g)} \rightarrow 2H_2O_{(aq)} + CO_{2(g)}$$

A. This is an example of complete combustion.
B. By increasing the concentration of CO_2, you can increase the rate of combustion.
C. The reaction is anaerobic.
D. Combustion of a gas always produces a liquid like water.
E. If you remove some of the oxygen you get more product.

Question 52:

Which of the following statements about carboxylic acids are true?

1. They can react with alcohols in the presence of a nickel catalyst to form esters.
2. The general formula is $C_nH_{2n+1}COOH$.
3. They can be formed by the oxidation of a secondary alcohol.

A. 1 only
B. 2 only
C. 3 only
D. 2 and 3
E. 1, 2 and 3

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Section 4

Question 53:

Make y the subject of the formula: $\frac{y + x}{x} = \frac{x}{a} + \frac{a}{x}$

A. $y = \frac{x^2}{a} + a$

B. $y = \frac{x^2 + a^2 - ax}{a}$

C. $y = \frac{-ax}{x^2 + a^2}$

D. $y = \frac{x^2}{ax} + a - x$

E. $y = a^2 - ax$

Question 54:

Consider the equations: A: $y = 3x$ and B: $y = \frac{6}{x} - 7$. At what values of x do the two equations intersect?

A. $x = 2$ and $x = 9$

B. $x = 3$ and $x = 6$

C. $x = 6$ and $x = 27$

D. $x = 6$

E. $x = 18$

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Question 55:

Rupert plays one game of tennis and one game of squash.

The probability that he will win the tennis game is $\frac{3}{4}$.

The probability that he will win the squash game is $\frac{1}{3}$.

What is the probability that he will win one game only?

A. $\frac{3}{12}$
B. $\frac{7}{12}$
C. $\frac{4}{5}$
D. $\frac{13}{12}$
E. $\frac{7}{6}$

Question 56:

What is the median of the following numbers: $\frac{7}{36}$; $0.\dot{3}$; $\frac{11}{18}$; 0.25; 0.75; $\frac{62}{72}$; $\frac{7}{7}$

A. $\frac{7}{36}$
B. $0.\dot{3}$
C. $\frac{11}{18}$
D. $\frac{62}{72}$
E. 0.75

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Question 57:
Two carriages of a train collide and then start moving together in the same direction. Carriage 1 has mass 12,000 kg and moves at $5ms^{-1}$ before the collision. Carriage 2 has mass 8,000 kg and is stationary before the collision.

What is the velocity of the two carriages after the collision?

A. $2\ ms^{-1}$
B. $3\ ms^{-1}$
C. $4\ ms^{-1}$
D. $4.5\ ms^{-1}$
E. $5\ ms^{-1}$

Question 58:
Which of the following points regarding electromagnetic waves are correct?

1. Radio waves have the longest wavelength and the lowest frequency.
2. Infrared has a shorter wavelength than visible light and is used in optical fibre communication, and heater and night vision equipment.
3. All of the waves from gamma to radio waves travel at the speed of light (about 300,000,000 m/s).
4. Infrared radiation is used to sterilise food and to kill cancer cells.
5. Darker skin absorbs more UV light, so less ultraviolet radiation reaches the deeper tissues.

A. 1 and 2
B. 1 and 3
C. 1, 3 and 5
D. 2 and 3
E. 2 and 4

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Question 59:

Which of the following statements are true?

1. Control rods are used to absorb electrons in a nuclear reactor to control the chain reaction.
2. Nuclear fusion is commonly used as an energy source.
3. An alpha particle is comprised of two protons and two neutrons and is the same as a helium nucleus.
4. When $^{14}_{6}C$ undergoes beta decay, an electron and $^{14}_{7}N$ are produced.
5. Beta particles are less ionising than gamma rays and more ionising than alpha particles.

A. 1 and 2
B. 1 and 3
C. 3 and 4
D. 3, 4 and 5
E. None

Question 60:

Simplify fully: $\frac{(3x^{1/2})^3}{3x^2}$

A. $\frac{3x}{\sqrt{x}}$
B. $\frac{9}{x}$
C. $3x^{1/2}$
D. $3x\sqrt{x}$
E. $\frac{9}{\sqrt{x}}$

END OF PAPER

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Mock Paper D: Section 1

Question 1:

The Mason-Dixon line, surveyed by Charles Mason and Jeremiah Dixon runs across which continent?

A. Asia
B. Africa
C. North America
D. South America
E. Europe

Question 2:

Franz Kafka lived in what central European Capital?

A. Berlin
B. Vienna
C. Budapest
D. Prague
E. Warsaw

Question 3:

Mansa Musa is sometimes considered to have been history's richest man. What empire did he rule?

A. Roman
B. Mongolian
C. Malian
D. Minoan
E. Japanese

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Question 4:
Japan invaded what region of China during the early 20th century?

A. Tibet
B. Manchuria
C. Inner Mongolia
D. Guangxi
E. Xinjiang

Question 5:
In 1492, Isabella and Ferdinand united what country?

A. Portugal
B. Spain
C. Italy
D. Denmark
E. Norway

Question 6:
What 'effect' is the change caused in a wavelength by the speed an observer is travelling?

A. Doppler effect
B. Mars effect
C. Hubble effect
D. Lambda effect
E. Euclid Effect

Question 7:
Which of these American cities was completely flooded during Hurricane Katrina?

A. New York
B. Chicago
C. San Francisco
D. New Orleans
E. Houston

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Question 8:
To a commit a crime with *mens rea* means to commit a crime with what?

A. Intention
B. A weapon
C. Ignorance
D. Anger
E. Accomplices

Question 9:
The 2008 Olympic Games were held in what country?

A. Japan
B. USA
C. China
D. Italy
E. UK

Question 10:
In January 2018, scientists in China cloned the first what?

A. Pigs
B. Monkeys
C. Sheep
D. Dolphin
E. Cows

Question 11:
What American Author wrote the critically acclaimed novel *No Country for Old Men* in 2005?

A. Cormac McCarthy
B. Herman Melville
C. Toni Morrison
D. Thomas Pynchon
E. John Steinbeck

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Question 12:
Newspeak is a word which comes from which book by George Orwell?

A. Nineteen Eighty Four
B. Down and Out in Paris and London
C. Homage to Catalonia
D. The Road to Wigan Pier
E. Animal Farm

Question 13:
To make a cake, you must prepare the ingredients and then bake it in the oven. You purchase the required ingredients from the shop; however your oven is broken. Therefore, you cannot make a cake.

Which of the following arguments has the same structure?
A. To get a good job, you must have a strong CV then impress the recruiter at interview. Your CV was not as good as other applicants; therefore you didn't get the job.
B. To get to Paris, you must either fly or take the Eurostar. There are flight delays due to dense fog; therefore you must take the Eurostar.
C. To borrow a library book, you must go to the library and show your library card. At the library, you realise you have forgotten your library card. Therefore, you cannot borrow a book.
D. To clean a bedroom window, you need a ladder and a hosepipe. Since you don't have the right equipment, you cannot clean the window.
E. Bears eat both fruit and fish. The river is frozen, so the bear cannot eat fish.

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Question 14:
Making model ships requires patience, skill and experience. Patience and skill without experience is common but often such people give up prematurely, since skill without experience is insufficient to make model ships, and patience can quickly be exhausted.

Which of the following summarises the main argument?
A. Most people lack the skill needed to make model ships.
B. Making model ships requires experience.
C. The most important thing is to get experience.
D. Most people make model ships for a short time but give up due to a lack of skill.
E. Successful model ship makers need to have several positive traits.

Question 15:
Joseph has a bag of building blocks of various shapes and colours. Some of the cubic ones are black. Some of the black ones are pyramid shaped. All blue ones are cylindrical. There is a green one of each shape. There are some pink shapes. Which of the following is definitely **NOT** true?

A. Joseph has pink cylindrical blocks.
B. Joseph has no pink cylindrical blocks.
C. Joseph has blue cubic blocks.
D. Joseph has a green pyramid.
E. Joseph doesn't have a black sphere.

Question 16:
A fair 6-faced die has 2 sides painted red. The die is rolled 3 times. What is the probability that at least one red side has been rolled?

A. $^{8}/_{27}$
B. $^{19}/_{27}$
C. $^{21}/_{27}$
D. $^{24}/_{27}$
E. 1

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Question 17:
In a furniture warehouse, all chairs have four legs. No tables have five legs, nor do any have three. Beds have no less than four legs, but one bed has eight, as they must have a multiple of four legs. Sofas have four or six legs. Wardrobes have an even number of legs, and sideboards have an odd number. No other furniture has legs. Brian picks a piece of furniture out, and it has six legs.

What can be deduced about this piece of furniture?

A. It is a table.
B. It could be either a wardrobe or a sideboard.
C. It must be either a table or a sofa.
D. It must be either a table, a sofa or a wardrobe.
E. It could be either a bed, a table or a sofa.

Question 18:
Two friends live 42 miles away from each other. They walk at 3mph towards each other. One of them has a pet falcon which starts to fly at 18mph as soon as the friends set off. The falcon flies back and forth between the two friends until the friends meet. How many miles does the falcon travel in total?

A. 63
B. 84
C. 114
D. 126
E. 252

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Question 19:
Antibiotic resistance is on the increase. As a result, many antibiotics are becoming ineffective against common infections. Probably the most significant contributor to this is the use of antibiotics in farming, as this exposes bacteria to antibiotics for no good reason, giving the opportunity for resistance to develop. If this worrying trend continues, we may, in 30 years' time, be back in the Victorian situation, where people die from skin or chest infections we consider mild today.

Which of the following best represents the overall conclusion of the passage?
A. Antibiotic resistance is a serious issue.
B. Antibiotics use in farming is essential.
C. The use of antibiotics in farming could cause us serious harm.
D. Victorians used to die from diseases we can treat today.
E. Antibiotics can treat skin infections

Question 20:
A complete set of maths equipment includes a pen, a pencil, a geometry set and a pad of paper. Pens cost £1.50, pencils cost 50p, paper pads cost £1, and geometry sets cost £3. Sam, Dave and George each want complete sets, but Mr Browett persuades them to share some items. Sam and Dave agree to share a paper pad and a geometry set. George must have his own pen but agrees that he and Sam can share a pencil.

What is the total amount spent?

A. £12.00
B. £13.50
C. £16.50
D. £17.50
E. £18.00

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Question 21:
Competitors need to be able to run 200 metres in under 25 seconds to qualify for a tournament. James, Steven and Joe are attempting to qualify. Steven and Joe run faster than James. James' best time over 200 metres is 26.2 seconds.

Which response is definitely true?

A. Only Joe qualifies.
B. James does not qualify.
C. Joe and Steven both qualify
D. Joe qualifies.
E. No one qualifies.

Question 22:
You spend £5.60 in total on a sandwich, a packet of crisps and a watermelon. The watermelon cost twice as much as the sandwich, and the sandwich cost twice the price of the crisps.

How much did the watermelon cost?

A. £1.20
B. £2.60
C. £2.80
D. £3.20
E. £3.60

END OF SECTION

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Section 2

Question 23:

Which of the following is **NOT** present in the Bowman's capsule?

A. Urea
B. Glucose
C. Sodium
D. Water
E. Haemoglobin

Question 24:

The primary ions responsible for an action potential on a muscle cell membrane are sodium and potassium. Sodium concentration is higher than that of potassium outside the cell. Potassium concentration is higher than that of sodium inside the cell. Depolarisation occurs when the membrane potential increases (becomes more positive).

Which of the following **must** be true when a muscle cell membrane depolarises?

A. More potassium moves into the muscle cell than sodium.
B. More sodium moves into the muscle cell than potassium.
C. There is no net flow of sodium or potassium ions.
D. The membrane potential becomes more negative.
E. None of the above.

Question 25:

Which of the following in NOT a polymer?

A. Polythene
B. Glycogen
C. Collagen
D. DNA
E. Triglyceride

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Question 26:
SIADH is a metabolic disorder caused by an excess of Anti-Diuretic Hormone (ADH) release by the posterior pituitary gland.

Which row best describes the urine produced by a patient with SIADH?

	Volume	Salt Concentration	Glucose
A	High	Low	Low
B	High	High	Low
C	High	High	High
D	Low	Low	Low
E	Low	High	Low

Question 27:
The normal cardiac cycle has two phases, systole and diastole.

During diastole, which of the following is **FALSE**?

A. The aortic valve is closed.
B. The ventricles are relaxing.
C. There is blood in the ventricles.
D. The pressure in the aorta increases.
E. The mitral valve is open.

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Questions 28-30 are based on the following information:
Patients with diabetes often have symptoms such as frequent urination, glucose in the urine, feeling thirsty and weight loss. Type I and type II diabetes have very different causes and have to be treated differently.

Question 28:
Which statement best describes the cause of type I diabetes?

A. Insulin-producing cells of the pancreas are destroyed by the body's own immune system.
B. The body becomes resistant to insulin, often due to the patient being obese for a long time.
C. Glucagon-producing cells of the pancreas are destroyed by the body's own immune system.
D. The pancreas cannot make sufficient insulin for the patient.
E. Insulin-producing cells of the pituitary gland are destroyed by the body's own immune system.

Question 29:
Which statement best describes why having diabetes can cause frequent urination?

A. A high blood glucose concentration draws more water into the blood by osmosis, increasing the blood volume, causing the bladder to fill faster.
B. A high blood glucose concentration means not all the glucose can be reabsorbed, which causes increased water retention in the nephron, as there is a smaller concentration gradient between the urine in the nephron and the surrounding tissue of the kidney.
C. A high blood glucose concentration stimulates chemoreceptors in the hypothalamus, causing the bladder to empty more regularly.
D. Patients with diabetes are very thirsty, so they drink more water, causing them to urinate more.
E. A low blood glucose concentration stimulates the brain to make the patient eat and drink more.

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Question 30:
Which of the following statements about the pancreas are correct?

1. Insulin is secreted from pancreatic beta cells.
2. Glucagon is secreted from pancreatic gamma cells.
3. The pancreas also produces amylases and proteases to aid digestion.

A. 1 only
B. 1 and 3
C. 2 and 3
D. 1, 2 and 3
E. None

Question 31:
Which of the following are properties of the alveoli of the lung?

1. The walls of the alveoli are thin, only one cell thick, to allow for rapid diffusion.
2. A rich network of arterioles and venules allow for rapid blood flow around the alveoli, in order to maintain the concentration gradient.
3. The walls of the alveoli are moist to ensure that all oxygen that enters the lung can be exchanged for CO_2.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

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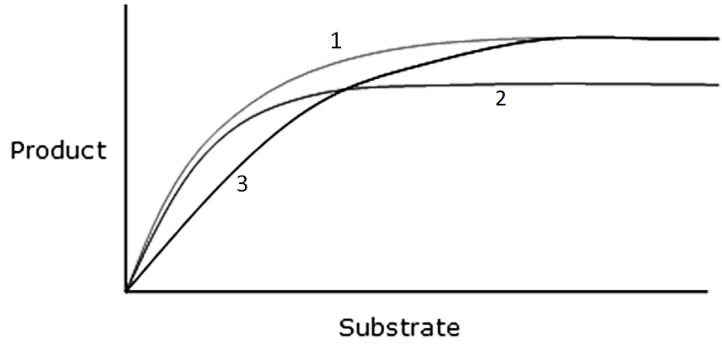
Question 32:
Below is a graph showing the concentration of a product over time as substrate concentration is increased. Some enzyme inhibitors are introduced.

Which, if any, line represents the effect of competitive inhibition?

A. Line 1
B. Line 2
C. Line 3
D. The x-axis
E. None



Question 33:
Which of the following is **NOT** present in the plasma membrane?

A. Extrinsic proteins
B. Intrinsic proteins
C. Phospholipids
D. Glycoproteins
E. Nucleic Acids

Question 34:
A pulmonary embolism occurs when a main artery supplying the lungs becomes blocked by a clot that has travelled from somewhere else in the body.

Which option best describes the path of a blood clot that originated in the leg and has caused a pulmonary embolism?

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1. Inferior vena cava
2. Superior vena cava
3. Right atrium
4. Right ventricle
5. Left atrium
6. Left ventricle
7. Pulmonary artery
8. Pulmonary vein
9. Coronary artery

A. 3, 4, 8, 7
B. 2, 3, 4, 8, 7
C. 9, 5, 6, 7
D. 1, 3, 4, 7
E. 1, 3, 4, 10, 7

Question 35:
Which of the following is **NOT** a hormone?

A. Insulin
B. Glycogen
C. Noradrenaline
D. Cortisol
E. Thyroxine

Question 36:
Which of the following statements regarding neural reflexes is **FALSE**?
A. Reflexes are usually faster than voluntary decisions.
B. Reflex actions are faster than endocrine responses.
C. The heat-withdrawal reflex is an example of a spinal reflex.
D. Reflexes are completely unaffected by the brain.
E. Reflexes are present in simple animals.

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Question 37:
Which of the following statements about the Krebs cycle are correct?

1. It occurs in the matrix of the mitochondria
2. 2 turns of the cycle produce a yield of 2 molecules of CO_2
3. NAD^+ is the only reducing agent that is used.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

Question 38:
Which of the following could induced pluripotent stem cells be used for?

1. To create new neurons to treat people paralysed due to nerve damage or trauma.
2. To help cure patients with leukaemia by creating new blood cells.
3. To help create artificial placentas for babies born too early to survive away from the mother.

A. 1 only
B. 1 and 2
C. 2 and 3
D. 1 and 3
E. 1, 2 and 3

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Question 39:
Which of the following best explains why a very high pH may denature an enzyme?

A. A strong base could dissolve the enzyme.
B. Hydrogen ions bind to the active site, preventing substrates from being able to bind properly.
C. The hydroxide ions form hydrogen bonds with some of the amino acid molecules, changing the shape of the active site.
D. The hydroxide ions break the peptide bonds between the amino acids.
E. The negative charge of the hydroxide ions alters the interactions between positively and negatively charged R groups of the different amino acids, changing the shape of the active site.

Question 40:
Anwar is an 11-year old boy who was recently diagnosed with a genetic condition called Henderson's syndrome. He goes to see a geneticist, who runs through the family history with his parents. His father is an only child and unaffected. He was adopted at the age of three and does not know his parents or genetic family. His mother is unaffected, but she recalls that she had a maternal uncle who was ill for many years but never diagnosed with anything, and a sister that died at a young age from an unknown illness. She never knew her father, but her mother was healthy. Her surviving brother is much older than him and all his children and grandchildren are healthy.

What is the most likely mode of inheritance?

A. Autosomal dominant
B. Autosomal recessive
C. X-linked recessive
D. X-linked dominant
E. Mitochondrial

END OF SECTION

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Section 3

Question 41:

Place the following substances in order from most to least reactive:

1. Sodium
2. Potassium
3. Aluminium
4. Zinc
5. Copper
6. Magnesium

A. 1, 2, 6, 3, 4, 5
B. 1, 2, 6, 3, 5, 4
C. 2, 1, 6, 3, 4, 5
D. 2, 1, 6, 3, 5, 4
E. 2, 6, 1, 3, 4, 5

Question 42:

A cup has 144ml of pure deionised water. How many electrons are in the cup due to the water? (Avogadro Constant = 6×10^{23})

A. 8.64×10^{24}
B. 8.64×10^{25}
C. 1.2×10^{24}
D. 4.8×10^{24}
E. 4.8×10^{25}

Question 43:

Steve's sports car requires 2.28kg of octane to travel to Pete's house 10 miles away. Calculate the mass of CO_2 produced during the journey.

A. 1.66 kg
B. 2.64 kg
C. 3.52 kg
D. 5.28 kg
E. 7.04 kg

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Question 44:
A group of five students are asked to identify five metals. They decide to do this using the flame test. Who has identified the metals correctly?

	Colours seen				
	Crimson	Yellow-orange	Lilac	Red-orange	Green
Poppy	Lithium	Sodium	Potassium	Calcium	Copper
Mabel	Lithium	Calcium	Copper	Sodium	Potassium
Storm	Sodium	Calcium	Lithium	Potassium	Copper
Otto	Potassium	Copper	Sodium	Lithium	Calcium
Claude	Sodium	Copper	Potassium	Calcium	Lithium

A. Poppy
B. Mabel
C. Storm
D. Otto
E. Claude

Question 45: B
Which is the correct equation for the complete combustion of heptane?

A. $C_7H_{16} + 3O_2 \rightarrow 3CO_2 + 4CH_4$
B. $C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$
C. $2C_7H_{16} + 15O_2 \rightarrow 14CO + 16H_2O$
D. $C_7H_{16} \rightarrow 7C + 8H_2$
E. $C_7H_{16} + 4O_2 \rightarrow 7C + 8H_2O$

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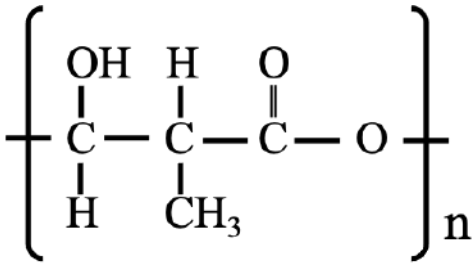
Question 46:
What is the IUPAC name for the monomer used to create this polymer?



A. 1,3-dihydroxy-2-methylpropanone
B. 3-hydroxybutanoic acid
C. 3-hydroxyl-2-methylpropanoic acid
D. 1-hydroxy-2-methylpropanoic acid
E. 1,3-dihydroxybutanone

Question 47:
Aisha is performing a titration in class. She finds that 50 cm^3 of sodium hydroxide of an unknown concentration is neutralised by 20 cm^3 of sulfuric acid with a concentration of 0.25 cm^3. What is the concentration of the sodium hydroxide?

A. 0.100 mol dm^{-3}
B. 0.200 mol dm^{-3}
C. 0.250 mol dm^{-3}
D. 0.500 mol dm^{-3}
E. Not enough information.

Question 48:
How many times greater is the concentration of hydrogen ions in a solution with a pH of 2 compared to a pH of 8?

A. 10
B. 100
C. 10,000
D. 1,000,000
E. 10,000,000

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Question 49:
Which of the following statements about alkenes are correct?

1. Due to the double carbon bond, alkenes are very reactive, so do not require a catalyst to undergo an addition reaction.
2. You can test for the presence of a double bond using bromine water; the solution will turn from colourless to brown.
3. An alkene with a straight chain of eight carbons and no other functional groups will be called octene.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1,2 and 3

Question 50:
Which of the rows in the following table about trends in alkanes are correct?

	Chain length	Boiling point	Volatility	Flammability
A	↑	↑	↑	↓
B	↓	↓	↓	↑
C	↑	↓	↓	↑
D	↑	↓	↑	↑
E	↓	↓	↑	↑

Question 51:
Which of the following statements about buffer solutions are correct?

1. An acidic buffer solution is commonly made from a weak acid and its salt.
2. An alkaline buffer solution is commonly made from a weak acid and a strong base, to ensure the pH is greater than 7.
3. The definition of a buffer solution is a solution that maintains a specific pH regardless of the pH of the substances that are added to it.

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A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 52:

A sample of a compound contains 9 grams of carbon, 2 grams of hydrogen and 4 grams of oxygen.

Which of the following could be the compound in question?

A. Ethanoic acid
B. Propanal
C. Butanone
D. Propanol
E. Octanediol

END OF SECTION

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Section 4

Question 53:

Calculate the radius of a sphere which has a surface area three times as great as its volume.

A. 0.5
B. 1
C. 1.5
D. 2
E. 2.5

Question 54:

A mechanical winch lifts up a bag of grain in a mill from the floor into a hopper.

Assuming that the machine is 100% efficient and lifts the bag vertically only, which of the following statements are **TRUE**?

1. This increases gravitational potential energy.
2. The gravitational potential energy is independent of the mass of the grain.
3. The work done is the difference between the gravitational potential energy at the hopper and when the grain is on the floor.
4. The work done is the difference between the kinetic energy of the grain in the hopper and on the floor.

A. 1 only
B. 1 and 3
C. 1 and 4
D. 1, 2 and 3
E. 1, 2 and 4

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Question 55:
A barometer records atmospheric pressure as 10^5 Pa. Recalling that the diameter of the Earth is 1.2 x 10^7 m, estimate the mass of the atmosphere. [Assume g = 10 ms^{-2}, the earth is spherical and that π=3]

A. 4.5 x 10^8 kg
B. 4.5 x 10^{10} kg
C. 4.5 x 10^{12} kg
D. 4.5 x 10^{13} kg
E. 4.5 x 10^{18} kg

Question 56:
A 6kg missile is fired and decelerates at 6ms^{-2}.

What is the difference in resistive force compared to a 2kg missile fired and decelerating at 8ms^{-2}?

A. 8N
B. 12N
C. 16N
D. 20N
E. 24N

Question 57:
There are 1000 international airports in the world. If 4 flights take off every hour from each airport, estimate the annual number of commercial flights worldwide, to the nearest 1 million.

A. 20 million
B. 35 million
C. 37 million
D. 40 million
E. 42 million

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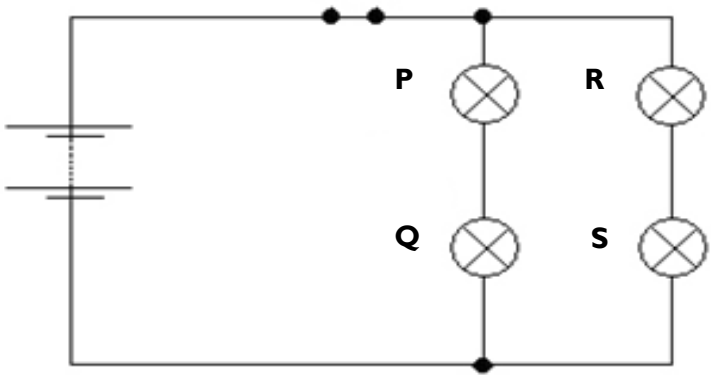
Question 58:

The figure below shows a schematic of a wiring system. All the bulbs have equal resistance. The power supply is 24V.



If headlight Q is replaced by a new one with twice the resistance, with the switch closed, which of these combinations of voltage drop across the four bulbs is possible?

	P	Q	R	S
A	8V	16V	12V	12V
B	8V	16V	16V	8V
C	8V	16V	8V	16V
D	12V	24V	24V	24V
E	12V	12V	12V	12V

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Question 59:

Given that:

- F + G + H = 1
- F + G – H = 2
- F – G – H = 3

Calculate the value of FGH.

A. -2
B. -0.5
C. 0
D. 0.5
E. 2

Question 60:

Put the following types of electromagnetic waves in ascending order of wavelength:

| Shortest - - -

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Mock Paper E: Section 1

Question 1:

What is the capital of Brazil?

A. Rio De Janeiro
B. Brasilia
C. Bogotá
D. Sao Paolo
E. Buenos Aires

Question 2:

Which two philosophers wrote The Communist Manifesto together?

A. Marx and Hegel
B. Marx and Schiller
C. Marx and Engels
D. Marx and Frege
E. Hegel and Schiller

Question 3:

The Minoan Civilisation was on what Mediterranean Island?

A. Crete
B. Malta
C. Cyprus
D. Sardinia
E. Rhodes

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Question 4:
Occam's razor is the philosophical principle that given two explanations for something, which one is preferred?

A. The longest
B. The most complex
C. The simplest
D. The most optimistic
E. The most radical

Question 5:
Which English Romantic poet wrote the line 'I wandered lonely as a cloud'?

A. Keats
B. Wordsworth
C. Shakespeare
D. John Donne
E. Byron

Question 6:
Which American politician was controversially awarded the Nobel Peace Prize for his dealings in the Vietnam war?

A. Henry Kissinger
B. Richard Nixon
C. Dick Cheney
D. Gerald Ford
E. Alan Greenspan

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Question 7:
Which British political party was founded in 1900?

A. Labour
B. Conservative
C. Whigs
D. Green
E. Liberal

Question 8:
In computing, what is the name given to the central component inside the computer?

A. Mainframe
B. Hub
C. Megatron
D. Mediacentre
E. Motherboard

Question 9:
Lord Admiral Nelson died during which battle?

A. Lepanto
B. Waterloo
C. Trafalgar
D. Balfour
E. St Petersburg

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Question 10:
Steve Jobs founded what company in 1976?

A. Apple
B. Microsoft
C. IBM
D. Tinder
E. Pixar

Question 11:
Which philosophers' *Meditations*, published in 1641, contained the maxim 'I think therefore I am'

A. Rene Descartes
B. Roger Bacon
C. Aristotle
D. Plato
E. Frederic Nietzsche

Question 12:
Which of the following countries does not use the Euro?

A. Spain
B. Czechia
C. Estonia
D. Montenegro
E. San Marino

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Question 13:
Hannah, Jane and Tom are travelling to London to see a musical. Hannah catches the train at 14:30. Jane leaves at the same time as Hannah but catches a bus which takes 40% longer than Hannah's train. Tom also takes a train, and the journey time is 10 minutes less then Hannah's journey, but he leaves 45 minutes after Jane leaves. He arrives in London at 16:20.

At what time will Jane arrive in London?

A. 15:45
B. 16:00
C. 16:15
D. 17:00
E. 17:15

Question 14:
At a show, there are two different ticket prices for different seats. The cost is £10 for a standard seat, and £16 for a premium view seat. The total revenue from a show is £6,600, and the total attendance was 600.

How many premium view seats were purchased?

A. 60
B. 100
C. 140
D. 180
E. 240

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Question 15:
The moon orbits the Earth once every 28 days. Between 20th January and 23rd May inclusive, how many degrees has the Moon turned through? This is not a leap year.

A. 1540°
B. 1560°
C. 1580°
D. 1600°
E. 1620°

Question 16:
Drama academies are special schools students can go to in order to learn performing arts. These schools are only available to the most skilled young performers and aim to give students the best training in the arts, whilst still covering mainstream academic subjects. However, many parents are reluctant for their children to attend such academies, as they feel the academic teaching will be worse than at a standard school.

Which of the following, if true, would most weaken the above argument?
A. Most top actors attended a drama academy as children.
B. There is as much time dedicated to academic work in drama academies as there is in normal schools.
C. The academic work comprises a greater proportion of the study time than drama related activities.
D. Most children are keen to attend a drama academy if given the opportunity.
E. 80% of students at drama academies attain higher than average GCSE scores.

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Question 17:
Anil and Suresh both leave point A at the same time. Anil travels 5 km east then 10 km north. Anil then travels a further 1 km north before heading 3 km west. Suresh travels east for 2 km less than Anil's total journey distance. He then heads 13 km north, before pausing and travelling back 2 km south. How far, as the crow flies, are the two men now apart?

A. 11 km
B. 12 km
C. 13 km
D. 15 km
E. 17 km

Question 18:
Chris leaves his house to go and visit Laura, who lives 3 miles away. He leaves at 17:30 and walks at 4 mph towards Laura's house, stopping for 5 minutes to chat to a friend. Meanwhile, Sarah also wants to visit Laura. She sets off from her house 6 miles away at 18:10, driving in her car and averaging a speed of 24 mph.

Who reaches the house first and for how long do they wait for the other person?

A. Chris, and waits 5 mins for Sarah
B. Chris, and waits 10 mins for Sarah
C. Sarah, and waits 5 mins for Chris
D. Sarah, and waits 10 mins for Chris
E. They both arrive at the same time

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Question 19:
Illegal film and music downloads have increased greatly in recent years. This causes significant harm to the relevant industries. Many people justify this to themselves by telling themselves they are only diverting money away from wealthy and successful singers and actors, who do not need any more money anyway. But in reality, illegal downloads are deeply harming the music industry, making many studio workers redundant and making it difficult for less famous performers to make a living.

Which of the following best summarises the conclusion of this argument?
A. Unemployment is a problem in the music industry.
B. Taking profits away from successful musicians does more harm than good.
C. Studio workers are most affected by illegal downloads.
D. Illegal downloads cause more harm than people often think.
E. Buying music legally helps keep the music industry productive.

Question 20:
40,000 litres of water will extinguish two typical house fires. 70,000 litres of water will extinguish two house fires and three garden fires. There is no surplus water.

Which statement is **NOT** true?
A. A garden fire can be extinguished with 12,000 litres, with water to spare.
B. 20,000 litres is sufficient to extinguish a normal house fire.
C. A garden fire requires only half as much water to extinguish as a house fire.
D. Two house and four garden fires will need 80,000 litres to extinguish.
E. Three house and ten garden fires will need 140,000 litres to extinguish.

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Question 21:
Plans are in place to install antennas underground, so that users of underground trains will be able to pick up mobile reception. There are, as usual, winners and losers from this policy. Supporters of the policy argue that it will lead to an increase in workforce productivity and increase convenience in day-to-day life. Critics respond by saying that it will lead to an annoying environment whilst travelling, it will facilitate the ease of conducting a terrorist threat and it will decrease levels of sociability. The latter camp seems to have the greatest support and so a re-consideration of the policy is urged.

Which of the following best summarises the conclusion of this passage?
A. The disadvantages of installing underground antennas outweigh the benefits.
B. The cost of the scheme is likely to be prohibitive.
C. The policy must be dropped, since a majority does not want it.
D. More people don't want this scheme than do want it.
E. A detailed consultation process should take place.

Question 22:
Ecosystems in the oceans are changing. Recently, restrictions on fishing have been imposed to tackle the decline in fish populations. As a result, farm fishing and the price of fish have increased, whilst the seas recover. It is hoped that these changes will lead to a brighter future for all.

Which of the following are TWO assumptions of this argument?
A. People will still buy farmed fish at a higher price.
B. The population of wild fish can recover.
C. Fishermen will benefit from working on this scheme.
D. Ecosystems have been altered as a result of climate change.
E. Heavy sea fishing is to blame for the changes in the ecosystem.

END OF SECTION

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Section 2

Question 23:

Which of the following statements, regarding normal human digestion, is **FALSE**?

A. Amylase is an enzyme which breaks down starch.
B. Amylase is produced by the pancreas.
C. Bile is stored in the gallbladder.
D. The small intestine is the longest part of the gut.
E. Glucagon is released in response to feeding.

Question 24:

Jane is one mile into a marathon. Which of the following statements is **NOT** true, relative to before she started?

A. Blood flow to the skin is increased.
B. Blood flow to the muscles is increased.
C. Blood flow to the gut is decreased.
D. Blood flow to the kidneys is decreased.
E. Cardiac output increases.

Question 25:

A newly discovered species of beetle is found to have 29.6% adenine (A) bases in its genome. What is the percentage of cytosine (C) bases in the beetle's DNA?

A. 20.4%
B. 29.6%
C. 40.8%
D. 59.2%
E. 70.6%

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Question 26:
Carbon monoxide binds irreversibly to the oxygen binding site of haemoglobin.

Which of the following statements is true regarding carbon monoxide poisoning?
A. Carbon monoxide poisoning has no serious consequences.
B. Haemoglobin is heavier, as both oxygen and carbon monoxide bind to it.
C. Affected individuals have a raised heart rate.
D. The CO_2 carrying capacity of the blood is decreased.
E. The O_2 carrying capacity of the blood is unchanged as it dissolves in the plasma instead.

Question 27:
Antibiotics can have serious side effects, such as liver failure and renal failure. Therefore, scientists are always trying to develop antibiotics to minimise these effects by targeting specific cellular components. Which of these cellular components offers the best way to treat infections and minimise side effects?

A. Mitochondrion
B. Cell membrane
C. Nucleic acid
D. Cytoskeleton
E. Flagellum

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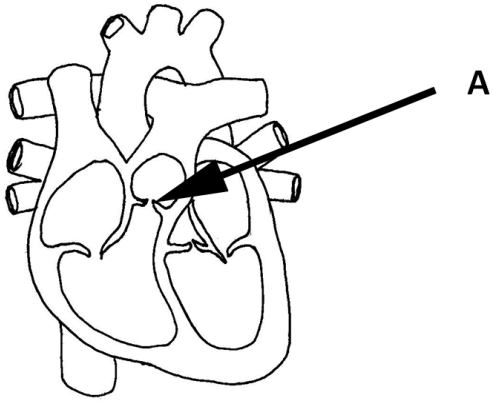
Question 28:

Study the following diagram of the human heart. What is true about structure A?



A. It prevents blood flowing into the left ventricle during systole.
B. It prevents blood flowing into the right ventricle during systole.
C. It prevents blood flowing into the left ventricle during diastole.
D. It opens due to left ventricular pressure being greater than aortic pressure.
E. It is open when the right ventricle is emptying

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Question 29:
A person responds to the starting gun of a race and begins to run. Place the following order of events in the most likely chronological sequence. Which option is a correct sequence?

1	Blood CO_2 increases	5	Impulses travel along relay neurones
2	The eardrum vibrates to the sound	6	Quadriceps muscles contract
3	Impulses travel along motor neurones	7	Glycogen is converted into glucose
4	Impulses travel along sensory neurones	8	Creatine phosphate rapidly re-phosphorylates ADP

A. $2 \rightarrow 5 \rightarrow 4 \rightarrow 3 \rightarrow 6 \rightarrow 7$
B. $2 \rightarrow 4 \rightarrow 3 \rightarrow 8 \rightarrow 6 \rightarrow 1$
C. $2 \rightarrow 3 \rightarrow 4 \rightarrow 6 \rightarrow 7 \rightarrow 1$
D. $2 \rightarrow 4 \rightarrow 3 \rightarrow 1 \rightarrow 6 \rightarrow 7$
E. $2 \rightarrow 4 \rightarrow 3 \rightarrow 6 \rightarrow 8 \rightarrow 7$

Question 30:
Which of the following best describes the events that occur during expiration?
A. The ribs move up and in; the diaphragm moves down.
B. The ribs move down and in; the diaphragm moves up.
C. The ribs move up and in; the diaphragm moves up.
D. The ribs move down and out; the diaphragm moves down.
E. The ribs move up and out; the diaphragm moves down.

Questions 31-33 are based on the following information:
A family of five are eating dinner together. Amy, the youngest daughter, is an 11-year old with type I diabetes. Her brother, William, is 9 and has not been diagnosed. Neither of her parents, Sheila and Sarah, have diabetes, though her grandfather has recently been diagnosed with type II diabetes.

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Question 31:
After a meal, the pancreas releases hormones to prevent large fluctuations in the blood glucose concentration. Which of the following statements best describes how Sheila's pancreas will respond after finishing her meal?

A. Alpha cells of the pancreas will release glucagon to increase the blood glucose level, so the organs of the digestive system have sufficient energy to digest the food and absorb the important nutrients.
B. Beta cells of the pancreas will release insulin to increase the blood glucose level, so the organs of the digestive system have sufficient energy to digest the food and absorb the important nutrients.
C. Alpha cells of the pancreas will release insulin so glucose from the meal is converted to glycogen and stored in the liver, muscle and fat cells.
D. Beta cells of the pancreas will release insulin, so glucose from the meal is converted to glycogen, preventing the blood glucose level becoming too high.
E. Alpha cells of the pancreas will release glucagon, so glucose from the meal is converted to glycogen, preventing the blood glucose level becoming too high.

Question 32:
Which of the following are risk factors for type II diabetes?

1. Obesity
2. Being of white European origin
3. Having a family history of the disease

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

Question 33:
Sarah works for a pharmaceutical company where they use genetic engineering to manufacture insulin in large quantities. Put the following statements in the correct order to explain how this can be done. Some steps may be used twice.

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1. Insert the insulin gene into the bacterial plasmid
2. This produces complementary sticky ends
3. Using a restriction enzyme
4. Cut into a bacterial plasmid
5. Using DNA ligase
6. Take the insulin gene from a human cell

A. 4 – 5 – 1 – 3 – 2 – 4 – 6
B. 6 – 5 – 4 – 5 – 2 – 1 – 3
C. 6 – 3 – 4 – 3 – 2 – 1 – 5
D. 4 – 5 – 1 – 5 – 6 – 3 – 2
E. 6 – 3 – 5 – 4 – 5 – 1 – 2

Question 34:

In aerobic respiration, how is water produced?

A. In oxidative phosphorylation, when oxygen accepts protons to form water.
B. In the Krebs cycle, when the 5-carbon compound is oxidised, and in oxidative phosphorylation, when oxygen accepts protons to form water.
C. In glycolysis, in the step before pyruvate is formed.
D. In glycolysis, in the step before pyruvate is formed, and in the Krebs cycle, when the 5-carbon compound is oxidised.
E. In glycolysis, in the step before pyruvate is formed, and in oxidative phosphorylation, when oxygen accepts protons to form water.

Question 35:

Which row of the following table about digestive enzymes and their product is correct?

	Enzyme	Substrates	Product/s
A	Lipase	Lipids	Fatty acids and glycogen
B	Protease	Protein	Amines and carboxylic acids
C	Amylase	Carbohydrates	Simple sugars
D	Protease	Bile	Amino acids
E	Lipase	Lipids	Fatty acids and glycerol

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Question 36:
Which of the following statements about gene expression are correct?

1. DNA methylation promotes gene transcription.
2. Histone acylation promotes gene transcription.
3. All genes that are present in the DNA code are transcribed.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 1, 2 and 3

Question 37:
In certain circumstances, bacteria can evolve antibiotic resistance. What is this an example of?

A. Darwinism
B. Lamarckism
C. Allopatric speciation
D. Artificial selection
E. Reproductive isolation

Question 38:
Which of the following statements about electrocardiography (ECG) are correct?

1. The P wave represents the contraction of the atria.
2. The T wave represents the contraction of the ventricles.
3. An arrythmia occurs when the heart beats too fast or too slow.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 39:
Which of the following statements about thermoregulation is correct?
A. Receptors for temperature are exclusively within the hypothalamus.
B. The initial response to a change in temperature is autonomic.
C. Blood plasma has a cooling effect on the internal organs.
D. When too hot, the hypothalamus stimulates peripheral arterioles to dilate.
E. When too cold, the hypothalamus stimulates erector pili muscles to relax.

Question 40:
Which of the following statements about the human liver are correct?

1. It is a large organ located on the left side of the body.
2. It is important for the storage of glucagon.
3. It is where urea is created.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 1 and 3

END OF SECTION

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Section 3

Question 41:

Which of the following below is **NOT** an example of an oxidation reaction?

A. $Li^+ + H_2O \rightarrow Li^+ + OH^- + \frac{1}{2}H_2$
B. $N_2 \rightarrow 2N^+ + 2e^-$
C. $2CH_4 + 2O_2 \rightarrow 2CH_2O + 2H_2O$
D. $2N_2 + O_2 \rightarrow 2N_2O$
E. $I_2 + 2e^- \rightarrow 2I^-$

Question 42:

Balance the following chemical equation. What is the value of **x**?

$$\mathbf{w}\ HIO_3 + 4FeI_2 + \mathbf{x}\ HCl \rightarrow \mathbf{y}\ FeCl_3 + \mathbf{z}\ ICl + 15H_2O$$

A. 5
B. 9
C. 15
D. 22
E. 25

Question 43:

On analysis, an organic substance is found to contain 41.4% carbon, 55.2% oxygen and 3.45% hydrogen by mass. Which of the following could be the chemical formula of this substance?

A. $C_3O_3H_{12}$
B. $C_4O_2H_4$
C. $C_4O_4H_4$
D. $C_4O_2H_8$
E. More information needed

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Question 44:
200 cm^3 of a 1.8 mol dm^{-3} solution of sodium nitrate ($NaNO_3$) is used in a chemical reaction. How many moles of sodium nitrate is this?

A. 0.09 mol
B. 0.36 mol
C. 9.00 mol
D. 36.0 mol
E. 360 mol

Question 45:
A is a Group 3 element and B is a Group 6 element. Which row best describes what happens to A when it reacts with B?

	Electrons are	Size of Atom
A	Gained	Increases
B	Gained	Decreases
C	Gained	Unchanged
D	Lost	Increases
E	Lost	Decreases

Question 46:
In relation to reactivity of elements in Group 1 and 2, which of the following statements is correct?

1. Reactivity decreases as you go down Group 1.
2. Reactivity increases as you go down Group 2.
3. Group 1 metals are generally less reactive than group 2 metals.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

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Question 47:
Which of the following have the same electron configuration?

1. Br^-
2. Ar
3. Ca^{2+}
4. K^{2+}
5. Na^-

A. 1 and 2
B. 2 and 3
C. 3 and 4
D. 4 and 5
E. 1 and 4

Questions 48-50 are based on the following information:
Benjamin is performing a titration in class. He has 40 cm^3 of sodium hydroxide in a conical flask, which he neutralises with 60 cm^3 of hydrochloric acid. The hydrochloric acid has a concentration of 0.3 mol dm^{-3}.

Question 48:
What is the concentration of the sodium hydroxide in mol dm^{-3}?

A. 0.45
B. 0.018
C. 0.3
D. 0.6
E. 0.9

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Question 49:
How many water molecules are present in the conical flask after the titration has been performed? Round Avogadro's number to 6×10^{23}.

A. 3.15×10^{22}
B. 3.15×10^{22}
C. 1.08×10^{22}
D. 1.08×10^{23}
E. 7.2×10^{24}

Question 50:
Benjamin's teacher, Mr. Afaz, is teaching a lesson on organic chemistry. He explains that an alkene will react with a hydrogen halide, like hydrochloric acid, to form a haloalkane. What is the mechanism of this reaction?

A. Nucleophilic substitution
B. Nucleophilic addition
C. Electrophilic substitution
D. Electrophilic addition
E. Esterification

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Question 51:
Arianna is attempting to identify a salt. She makes the following observations:

- When added to dilute sulfuric acid, bubbles are produced.
- She bubbles the gas through limewater, which quickly turns cloudy when shaken.
- When she adds sodium hydroxide to the sample, a blue precipitate is produced.

What is the chemical formula of the solution?

A. $MgSO_4$
B. $Al_2(CO_3)_2$
C. $CuCO_3$
D. $MgBr_2$
E. $CuCl_2$

Question 52:
What are the products of the reaction between butanol and sodium?

A. Sodium propanoate and methanol
B. Sodium propoxide and methane
C. Sodium butoxide and hydrogen
D. Sodium butanoate and hydrogen
E. Sodium butanoate and water

END OF SECTION

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Section 4

Question 53:

The buoyancy force of an object is the produce of its volume, density and the gravitational constant, *g*. A boat weighing 600 kg with a density of 1000 kgm^{-3} and hull volume of 950 litres is placed in a lake.

What is the minimum mass that, if added to the boat, will cause it to sink? Use g = $10ms^{-1}$.

A. 3.55 kg
B. 35 kg
C. 350 kg
D. 355 kg
E. 3550 kg

Question 54:

Mr Khan fires a bullet parallel to the floor at a speed of 310 ms^{-1} from a height of 1.93 m. Mr Weeks drops an identical bullet from the same height.

What is the time difference between the bullets first making contact with the floor? [Assume that there is negligible air resistance; g = 10 ms^{-2}]

A. 0 s
B. 0.2 s
C. 1.93 s
D. 2.1 s
E. More information needed

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Question 55:
A 1.4 kg fish swims through water at a constant speed of 2 ms^{-1}. Resistive forces against the fish are 2 N. Assuming g = 10ms^{-2}, how much work does the fish do in one hour?

A. 7,200 J
B. 10,080 J
C. 14,400 J
D. 19,880 J
E. 22,500 J

Question 56:
A crane is 40 m tall. The lifting arm is 5 m long and the counterbalance arm is 2 m long. The beam joining the two weighs 350 kg and is of uniform thickness. The lifting arm lifts a 2000 kg mass. What counterbalance mass is required to balance exactly around the centre point? Use g = 10 ms^{-2}.

A. 4,220 kg
B. 4,820 kg
C. 5,013 kg
D. 5,263 kg
E. 10,525 kg

Question 57:
For Christmas, Mr James decorates his house with 20 strings of 150 bulbs each. Each 150-bulb string of lights is rated at 50 Watts. Mr James turns the lights on at 8pm and off at 6am each night. The lights are used for 20 days in total.

If 100 kJ of energy costs 2p, how much is the total cost Mr James has to pay?

A. £2160.00
B. £144.00
C. £14.40
D. £0.72
E. £0.24

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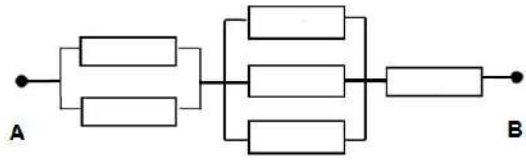
Question 58:
Calculate the perimeter of a regular polygon each interior angle is 150° and each side is 15 cm.

A. 75 cm
B. 150 cm
C. 180 cm
D. 225 cm
E. 1,500 cm

Question 59:
The diagram shown to the right depicts an electrical circuit with multiple resistors, each with equal resistance, *Z*. The total resistance between A and B is 22 MΩ. Calculate the value of *Z*.



A. 3.33 MΩ
B. 4.33 MΩ
C. 7.33 MΩ
D. 11 MΩ
E. 12 MΩ

Question 60:
A cylindrical candle of diameter 4cm burns steadily at a rate of 1cm per hour. Assuming the candle is composed entirely of paraffin wax ($C_{24}H_{52}$) of density 900 kgm^{-3} and undergoes complete combustion, how much energy is transferred in 30 minutes?

You may assume the molar combustion energy is 11,000 $kJmol^{-1}$, and that $\pi = 3$.
A. 140,000 J
B. 175,000 J
C. 185,000 J
D. 200,500 J
E. 215,000 J

END OF PAPER

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Mock Paper F: Section 1

Question 1:

The first interstellar object to be detected passing through our solar system was discovered in 2017 by scientists in Hawaii. What was it named?

A. Oumuamua
B. Maui
C. Io
D. Hammurabi
E. Europa

Question 2:

In Greek mythology Zeus transformed into what animal to seduce Leda?

A. Goose
B. Swan
C. Bull
D. Mouse
E. Horse

Question 3:

Which British monarch took over Hampton Court as his palace in 1529?

A. James I
B. Edward I
C. Henry VII
D. Henry VIII
E. Edward VI

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Question 4:
An anemometer is used to measure what?

A. Air pressure
B. Time
C. Windspeed
D. Depth
E. Altitude

Question 5:
The Taiping rebellion took place in which country?

A. Japan
B. Korea
C. Russia
D. China
E. Vietnam

Question 6:
Which scientist sailed on the Beagle to the Galapagos islands?

A. Charles Darwin
B. Gregor Mendel
C. Robert Brown
D. Rachel Carson
E. Alexander Fleming

Question 7:
Sir Isaac Newton and what other thinker both invented calculus at the same time?

A. Albert Einstein
B. Kurt Gödel
C. Baruch Spinoza
D. Gottfried Leibniz
E. Euclid

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Question 8:
In 1819, the Peterloo massacre in Manchester occurred following a protest for what?

A. Tax relief
B. Parliamentary representation
C. An end to the war
D. House of Lords reform
E. Free healthcare

Question 9:
Which of these countries has never been in the European Union?

A. Switzerland
B. Spain
C. Austria
D. Sweden
E. Croatia

Question 10:
Which religion from Iran is the first known monotheistic religion?

A. Sikhism
B. Islam
C. Christianity
D. Judaism
E. Zoroastrianism

Question 11:
Which of these is not one of the official languages of India?

A. Hindi
B. Punjabi
C. Urdu
D. Bengali
E. Pashto

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Question 12:
Which US president was in office during the Cuban missile crisis?

A. John F Kennedy
B. Lyndon B Johnson
C. George W Bush
D. Gerald Ford
E. Jimmy Carter

Question 13:
Every year, there are tens of thousands of motor crashes, causing a serious number of fatalities. Indeed, this represents the leading cause of death in the UK that is not a disease. In spite of this horrendous statistic, there are still thousands of uninsured drivers. The government is under moral obligation to clamp down on uninsured drivers, to reduce the incidence of such crashes. That they have not acted is arguably the most outrageous failing of the present government.

Which of the following is the best statement of a **flaw** in this passage?
A. It has made unsupported claims that the government's failure to act is morally outrageous.
B. It has not provided any evidence to support its claims that motor crashes are the leading cause of death in the UK outside of diseases.
C. Even if motor crashes were prevented, it would not save lives of people who die from other causes.
D. It has implied that lack of insurance is related to the incidence of motor crashes.
E. It has fabricated an obligation on the government's part to intervene and reduce the numbers of uninsured drivers.

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Question 14:
Several years ago the Brazilian government held a referendum of the populace, to decide whether they should enact a law banning the ownership of guns. The Brazilian people voted strongly against this proposal. When asked why this had happened, one commentator said he believed the reason was that 90% of criminals who use guns to commit crimes buy their weapons on the black market, illegally. Thus, if Brazil were to ban the legal sale of guns, this would remove the ability of law-abiding citizens to purchase protection, whilst doing little to remove weapons from the hands of criminals.

Some commentators have pointed to this statistic, and claimed that the UK should also legalise guns, to allow citizens to protect themselves. However, in the UK the black market for weapons is not as widespread as in Brazil. Most people in the UK have little reason to fear gun attacks and legalising the sale of guns would simply make it much easier for criminals to acquire weapons.

Which of the following best expresses the main conclusion of this passage?
A. The UK should not follow Brazil's lead on gun legislation.
B. Efforts to reduce gun ownership should focus on the black market.
C. Violent crime is a more pressing concern in Brazil than the UK.
D. Legalising the sale of guns in the UK would result in widespread ownership.
E. Criminals will always find a way to obtain firearms.

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Question 15:
Hannah is buying tiles for her new bathroom. She wants to use the same tiles on the floor and all four walls, and for all the walls to be completely tiled apart from the door. The bathroom is 2.4 metres high, 2 metres wide, and 2 metres long and the door is 2 metres high, 80cm wide and at the end of one of the 4 identical walls. The tiles she wants to use are 40cm x 40cm.

How many of these tiles does she need to tile the whole bathroom?

A. 110
B. 120
C. 135
D. 145
E. 15

Question 16:
ABC taxis charges a rate of 15p per minute, plus £4. XYZ taxis charges a rate of £4 plus 30p per mile. I live 6 miles from the station.

What would the taxi's average speed have to be on my journey home from the station for the two taxi firms to charge exactly the same fare?

A. 25
B. 30
C. 45
D. 55
E. 60

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Question 17:
If John gives Michael £20, the ratio of their money is 2:1. If Michael gives John £5, the ratio of John's money to Michael's is 5:1. How much money do they have combined?

A. £180
B. £120
C. £90
D. £210
E. £150

Question 18:
Adam's grandmother has sent him to the shop to buy bread rolls. Usually, bread rolls are 30p for a pack of 6 and so his grandmother has given him the exact amount to buy a certain number of bread rolls. However, today there is a special offer whereby if you buy 3 or more packs of rolls, the price per roll is reduced by 1p. He can now buy 1 more pack than before and get no change.

How many bread rolls was he originally supposed to be buying?

A. 4
B. 5
C. 6
D. 24
E. 30

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Question 19:

	Boys Absenteeism	Girls Absenteeism	Pupils on Roll	Average
Hazelwood Grammar	7%	Boys' School	300	7%
Heather Park Academy	5%	6%	1000	5.60%
Holland Wood Comprehensive	5%	6%	500	5.60%
Hurlington Academy	Girls' School		200	
Average		7%		

Some of the information is missing from the table above. What is the rate of girls' absenteeism at Hurlington Academy?

A. 6.5%
B. 7%
C. 9%
D. 11.5%
E. 13%

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Question 20:

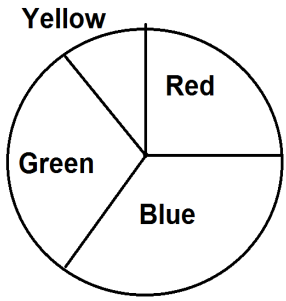
Harriet is a headteacher and she is making 400 information packs for the sixth form open evening. Each information pack needs to have 2 double-sided sheets of A4 of general information about the school. She also needs to produce 50 A5 single-sided sheets about each of the 30 A Level courses on offer. Single-sided A5 costs £0.01 per sheet. Double-sided costs twice as much as single-sided. A4 printing costs 1.5 times as much as A5.

How much does she spend altogether on the printing?

A. £27
B. £31
C. £35
D. £39
E. £43

Question 21:

The pie chart shows the voting intentions of some constituents interviewed by a polling group, prior to an upcoming election. How many times more people said their intention was to vote for the red party than the yellow party?



A. 2
B. 3
C. 4
D. 5
E. 6

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Question 22:

	Goals Scored	Goals Conceded
City	10	4
United	8	5
Rovers	1	10

The table above shows the goal scoring record of teams in a football tournament. Each team plays the other teams twice, once at home and once away.

Here are the results of the first 4 matches:

- United 2 – 2 City
- Rovers 0 – 3 City
- City 2 – 1 Rovers
- Rovers 0 – 3 United

What were the results of the final two fixtures?

A. United 2 – 0 Rovers, City 0 – 0 United
B. United 1 – 0 Rovers, City 1 – 1 United
C. United 0 – 0 Rovers, City 2 – 1 United
D. United 1 – 0 Rovers, City 2 – 2 United
E. United 2 – 0 Rovers, City 3 – 1 United

END OF SECTION

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Section 2

Question 23:

Why do cells undergo mitosis?

1. Asexual Reproduction
2. Sexual Reproduction
3. Growth of the human embryo
4. Replacement of dead cells

A. 1 only
B. 2 and 3
C. 1, 2, and 3
D. 1, 3, and 4
E. 2, 3, and 4

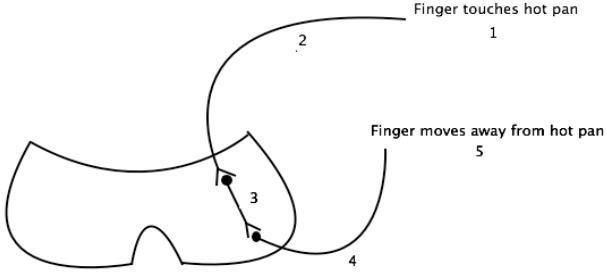
Question 24:

In a healthy person, which one of the following has the highest blood pressure?

A. The vena cava
B. The systemic capillaries
C. The pulmonary artery
D. The pulmonary vein
E. The aorta

The following information applies to questions 25 - 26:

Professor Huang accidentally touches a hot pan and her hand moves away in a reflex action. The diagram below shows a schematic of the reflex arc involved.



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Question 25:
Which option correctly identifies the labels in the pathway?

	Muscle	Sensory Neurone	Receptor	Motor Neurone
A	1	2	3	4
B	2	3	1	5
C	5	2	1	4
D	1	4	5	2
E	3	4	5	2

Question 26:
Which one of the following statements is correct?

1. Information passes between 1 and 2 chemically.
2. Information passes between 2 and 3 electrically.
3. Information passes between 3 and 4 chemically.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 27:
Which of the following statements about hormonal contraception are correct?

1. All hormonal contraceptives contain progesterone.
2. The combined pill inhibits ovulation and thickens the cervical mucus.
3. Hormonal contraceptives usually work by increasing the levels of LH.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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The following information applies to questions 28 - 29:
Duchenne muscular dystrophy (DMD) is inherited in an X-linked recessive pattern. A man with DMD has two boys with a woman carrier.

Question 28:
What is the probability that both boys have DMD?

A. 100%
B. 75%
C. 50%
D. 25%
E. 0%

Question 29:
If the same couple had two more children, what is the probability that they are both girls with DMD?

A. 100%
B. 75%
C. 50%
D. 25%
E. 12.5%

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Question 30:

Which of the following statements best explains why a high temperature can denature an enzyme?

A. As the temperature rises, the peptide bonds of the enzyme gain more kinetic energy and some can eventually break, changing the shape of the active site so the substrate no longer fits.
B. A high temperature increases the solubility of the enzyme, so it dissolves in the blood plasma or extracellular fluid.
C. As the temperature rises, the hydrogen bonds of the enzyme gain more kinetic energy and some can eventually break, changing the shape of the active site so the substrate no longer fits.
D. A high temperature alters the primary structure of an enzyme to an extent where the substrate can no longer bind.
E. A high temperature increases the dissociation of hydrogen ions from surrounding fluid which exert a strong charge on the bonds of an enzyme, changing the shape of the active site.

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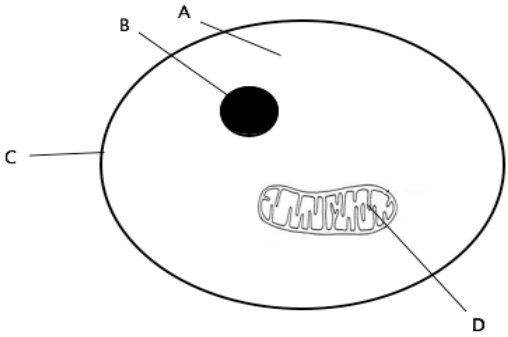
Question 31:
Which row of the table is correct regarding the cell shown below?



	Most Chemical Reactions occur here	Involved in Energy Release	Cell Type
A	A	B	Animal
B	A	B	Bacterial
C	A	D	Animal
D	B	D	Bacterial
E	B	B	Animal

Question 32:
Which of the following statements about white blood cells is correct?

1. They act by engulfing pathogens such as bacteria.
2. They are able to kill pathogens.
3. They transport carbon dioxide away from dying cells.

A. Only 1
B. Only 2
C. Only 3
D. 1 and 2
E. 2 and 3

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Question 33:
Which of the following statements about the Loop of Henle are correct?

1. The ascending limb is permeable to water.
2. ADH does not act on the Loop of Henle.
3. In a healthy person, all glucose is reabsorbed in the proximal convoluted tubule.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 34:
Which of the following statements about the link reaction of respiration are correct?

1. The link reaction occurs in the cytosol.
2. One carbon dioxide molecule is produced.
3. Pyruvate combines with coenzyme A.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 35:
James is looking at cells undergoing meiosis. He notices one cell, which has pairs of chromosomes lining up along the equator. Which stage of meiosis is the cell in?

A. Metaphase I
B. Anaphase I
C. Metaphase II
D. Anaphase II
E. Telophase II

Question 36:
What features protect the genetic code from harmful effects if a mutation occurs?

1. Translocation
2. Degeneracy
3. No overlap between codons

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 37:
Which of the following cells contains the least amount of circular DNA?

A. E.coli bacteria
B. Ciliated epithelial cells of the lung
C. Red blood cells
D. Relay neurons
E. Yeast cells

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Question 38:
Which of the following statements about transcription are correct?

1. DNA helicase breaks hydrogen bonds between complementary base pairs of the DNA.
2. RNA polymerase binds to promoter DNA to initiate transcription.
3. Transcription occurs at the ribosome.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 39:
Which of the following statements about spermatogenesis are correct?

1. Spermatogenesis occurs in the seminiferous tubules.
2. Spermatids divide to form spermatocytes.
3. Spermatids are formed after the first meiotic division.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

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Question 40:
Which of the following statements about photosynthesis are correct?

1. Grana are disc-shaped structures inside the chloroplast that are arranged into thylakoids.
2. The Calvin cycle refers to the reaction where light energy that enters the chloroplast powers an electron transport chain that eventually splits water molecules, releasing hydrogen and oxygen.
3. Carbon fixation occurs in the light-independent reaction.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

END OF SECTION

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Section 3

Question 41:

Which of the following correctly describes the product of the reaction between hydrochloric acid and but-2-ene?

A. CH_3-CH_2-C(Cl)H-CH_3
B. CH_3-C(Cl)-CH_2-CH_3
C. C(Cl)H_2-CH_2-CH_2-CH_3
D. CH_3-CH_2-CH_2-C(Cl)H_2
E. None of the above.

Question 42:

The electrolysis of brine can be represented by the following equation: 2 NaCl + 2 X = 2 Y + Z + Cl_2

What are the correct formulae for X, Y and Z?

	X	*Y*	*Z*
A	H_2O	H_2	O_2
B	H_2O	NaOH	O_2
C	H_2O	NaOH	H_2
D	H_2	H_2O	O_2
E	H_2	NaOH	O_2

Question 43:

An unknown element has two isotopes: ^{76}X and ^{78}X. A_r = 76.5. Which of the statements below are true of X?

1. ^{76}X is three times as abundant as ^{78}X.
2. ^{78}X is three times as abundant as ^{76}X.
3. ^{76}X is more stable than ^{78}X.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 2 and 3

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Question 44:
For the following reaction, which of the statements below is true?

$$6CO_{2\,(g)} + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_{2\,(g)}$$

A. Increasing the concentration of the products will increase the reaction rate.
B. Whether this reaction will proceed at room temperature is independent of the entropy.
C. The reaction rate can be monitored by measuring the volume of gas released.
D. This reaction represents aerobic respiration.
E. This reaction represents anaerobic respiration.

Question 45:
Which of the following are true about the formation of polymers?

1. They are formed from saturated molecules.
2. Water can be released when polymers form.
3. Polymers only form linear molecules.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 3
E. 2 and 3

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Question 46:
Helena is trying to identify an unknown compound, X. She records the following observations:

- A white precipitate is formed when barium chloride and dilute hydrochloric acid are added.
- When aqueous sodium hydroxide is added, a green precipitate forms.

What is X?
A. Iron (II) sulfate
B. Iron (III) carbonate
C. Magnesium sulfate
D. Aluminium chloride
E. Magnesium bromide

Question 47:
Which of the following equations regarding organic chemistry synthesis pathways is incorrect?

A. $NaBH_4$ and an acid catalyst can reduce an aldehyde to a primary alcohol and a carboxylic acid to an aldehyde.
B. Potassium dichromate can oxidise a secondary alcohol to a ketone.
C. The reaction of sodium hydroxide with a haloalkane will produce an alcohol.
D. Carboxylic acids can react with alcohols to form esters if an acid catalyst is present.
E. For an alkene to react with a hydrogen halide to form a haloalkane, no catalyst is required.

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Question 48:
Which of the following statements about electron affinity are correct?

1. Electron affinities are always negative.
2. The second electron affinity is defined as the energy required to add one electron to each ion in one mole of gaseous 1- ions, creating one mole of gaseous 2- ions.
3. The general trend seen in electron affinity is that is decreases down a group.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

Question 49:
Oliver has reacted 35 g of potassium carbonate with an excess of sulfuric acid. He obtains 22 g of potassium sulfate. To one significant figure, what is the percentage yield of this reaction?
A_r (S) = 32, A_r (K) = 39

A. 20%
B. 30%
C. 40%
D. 50%
E. 60%

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Question 50:
Anisha reacts calcium with an excess of nitric acid and obtains 120 cm^3 of hydrogen gas. Assuming the percentage yield of hydrogen was 40%, and that the reaction took place at room temperature and pressure, what mass of calcium did Anisha use? A_r (Ca) = 40

A. 0.4 g
B. 0.5 g
C. 0.8 g
D. 0.9 g
E. 1.5 g

Question 51:
Which of the following reactions is an example of a disproportionation reaction?

A. $Cu_2O + H_2SO_4 \rightarrow Cu + CuSO_4 + H_2O$
B. $Cu + H_2SO_4 \rightarrow CuSO_4 + H_2$
C. $NH_4Cl \Leftrightarrow NH_3 + HCl$
D. $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + H_2O$
E. $C_2H_4 + HBr \rightarrow C_2H_5Br$

Question 52:
Which of the following statements about bases are correct?

1. They can be defined either as substances that form aqueous hydroxide ions or as proton acceptors.
2. The reaction of a base with an acid is endothermic.
3. A base with a pH of 14 will turn universal indicator solution blue.

A. 1 only
B. 2 only
C. 3 only
D. 1 and 2
E. 2 and 3

END OF SECTION

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Section 4

Question 53:

A ball of radius 2 m and density 3 kg/m^3 is released from the top of a frictionless ramp of height 20 m and rolls down. What is its speed at the bottom? Take $\pi = 3$ and $g = 10$ ms^{-2}.

A. 1 ms^{-1}
B. 4 ms^{-1}
C. 7 ms^{-1}
D. 9 ms^{-1}
E. 14 ms^{-1}
F. 20 ms^{-1}

Question 54:

Which of the following statements is true regarding waves?

A. Waves can transfer mass in the direction of propagation.
B. All waves have the same energy.
C. All light waves have the same energy.
D. Waves can interfere with each other.
E. None of the above.

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Question 55:

Rearrange $\frac{(7x+10)}{(9x+5}$ = $3z^2$ + 2, to make x the subject.

A. $\frac{15\,z^2}{7 - 9(3z^2+2)}$

B. $\frac{15\,z^2}{7 + 9(3z^2+2)}$

C. $-\frac{15\,z^2}{7 - 9(3z^2+2)}$

D. $-\frac{15\,z^2}{7 + 9(3z^2+2)}$

E. $-\frac{15\,z^2}{7 + 3(3z^2+2)}$

Question 56:

Element $^{188}_{90}$X decays into two equal daughter nuclei after a single alpha decay and the release of gamma radiation. What is the daughter element?

A. $^{91}_{45}$D

B. $^{92}_{44}$D

C. $^{184}_{88}$D

D. $^{186}_{90}$D

E. $^{186}_{45}$D

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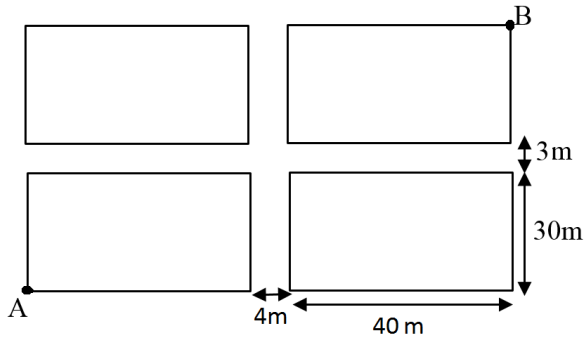
Question 57:

The diagram to the right shows a series of identical sports fields:



Calculate the shortest distance between points A and B.

A. 100 m
B. 105 m
C. 146 m
D. 148 m
E. 154 m

Question 58:

Calculate $\frac{1.25 \times 10^{10} + 1.25 \times 10^{9}}{2.5 \times 10^{8}}$

A. 0
B. 1
C. 55
D. 110
E. 1.25×10^{8}

Question 59:

Solve $y = 2x - 1$ and $y = x^2 - 1$ for x and y.

A. (0, -1) and (2, 3)
B. (1, -1) and (2, 2)
C. (1, 4) and (3, 2)
D. (2, -3) and (4, 5)
E. (3, -1) and (3, 1)

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Question 60:
Tim stands at the waterfront and holds a 30 cm ruler horizontally at eye level one metre in front of him. It lines up so it appears to be exactly the same length as a cruise ship 1 km out to sea. How long is the cruise ship?

A. 299.7 m
B. 300.0 m
C. 333.3 m
D. 29,970 m
E. 30,000 m

END OF PAPER

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ANSWER KEYS

Paper A							
Section 1		**Section 2**		**Section 3**		**Section 4**	
1	A	**23**	A	**41**	E	**53**	B
2	B	**24**	E	**42**	B	**54**	D
3	A	**25**	D	**43**	B	**55**	B
4	B	**26**	B	**44**	E	**56**	C
5	E	**27**	D	**45**	D	**57**	A
6	C	**28**	D	**46**	C	**58**	C
7	C	**29**	B	**47**	B	**59**	B
8	B	**30**	E	**48**	B	**60**	C
9	E	**31**	E	**49**	E		
10	A	**32**	A	**50**	B		
11	A	**33**	D	**51**	A		
12	C	**34**	B	**52**	A		
13	E	**35**	D				
14	A	**36**	B				
15	D	**37**	A				
16	B	**38**	E				
17	C	**39**	E				
18	B	**40**	A				
19	D						
20	E						
21	C						
22	B						

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Paper B							
Section 1		**Section 2**		**Section 3**		**Section 4**	
1	E	**23**	D	**41**	E	**53**	A
2	E	**24**	E	**42**	A	**54**	D
3	D	**25**	E	**43**	D	**55**	D
4	C	**26**	D	**44**	A	**56**	C
5	D	**27**	A	**45**	D	**57**	D
6	D	**28**	C	**46**	A	**58**	D
7	C	**29**	C	**47**	B	**59**	C
8	D	**30**	E	**48**	C	**60**	B
9	E	**31**	D	**49**	A		
10	D	**32**	E	**50**	E		
11	A	**33**	B	**51**	C		
12	C	**34**	C	**52**	A		
13	A	**35**	E				
14	E	**36**	E				
15	E	**37**	C				
16	B	**38**	C				
17	B	**39**	D				
18	C	**40**	A				
19	E						
20	E						
21	B						
22	A						

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Paper C							
Section 1		Section 2		Section 3		Section 4	
1	B	**23**	C	**41**	C	**53**	B
2	B	**24**	C	**42**	D	**54**	C
3	B	**25**	C	**43**	A	**55**	B
4	C	**26**	D	**44**	E	**56**	C
5	E	**27**	B	**45**	B	**57**	B
6	C	**28**	E	**46**	D	**58**	C
7	E	**29**	E	**47**	C	**59**	C
8	B	**30**	D	**48**	B	**60**	E
9	D	**31**	A	**49**	A		
10	A	**32**	C	**50**	A		
11	A	**33**	B	**51**	A		
12	E	**34**	B	**52**	B		
13	A	**35**	E				
14	E	**36**	C				
15	E	**37**	E				
16	C	**38**	D				
17	C	**39**	B				
18	D	**40**	A				
19	C						
20	E						
21	D						
22	C						

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Paper D							
Section 1		Section 2		Section 3		Section 4	
1	C	23	E	41	C	53	B
2	D	24	B	42	E	54	B
3	C	25	E	43	E	55	E
4	B	26	E	44	A	56	D
5	B	27	D	45	B	57	B
6	A	28	A	46	C	58	A
7	D	29	B	47	B	59	D
8	A	30	B	48	D	60	E
9	C	31	A	49	C		
10	B	32	B	50	E		
11	A	33	E	51	A		
12	A	34	D	52	D		
13	C	35	B				
14	E	36	D				
15	C	37	A				
16	B	38	B				
17	D	39	E				
18	D	40	C				
19	C						
20	B						
21	B						
22	D						

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Paper E							
Section 1		**Section 2**		**Section 3**		**Section 4**	
1	B	**23**	E	**41**	E	**53**	D
2	C	**24**	D	**42**	E	**54**	A
3	A	**25**	A	**43**	D	**55**	C
4	C	**26**	C	**44**	B	**56**	D
5	B	**27**	E	**45**	E	**57**	B
6	A	**28**	E	**46**	B	**58**	C
7	A	**29**	E	**47**	B	**59**	E
8	E	**30**	B	**48**	A	**60**	B
9	C	**31**	D	**49**	C		
10	A	**32**	D	**50**	D		
11	A	**33**	C	**51**	C		
12	B	**34**	E	**52**	C		
13	C	**35**	E				
14	B	**36**	B				
15	C	**37**	A				
16	E	**38**	A				
17	D	**39**	D				
18	A	**40**	C				
19	D						
20	E						
21	D						
22	D						

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Paper F							
Section 1	**Section 2**		**Section 3**		**Section 4**		
1	A	**23**	D	**41**	A	**53**	E
2	B	**24**	E	**42**	C	**54**	D
3	D	**25**	C	**43**	A	**55**	A
4	C	**26**	C	**44**	C	**56**	B
5	D	**27**	D	**45**	E	**57**	B
6	A	**28**	D	**46**	A	**58**	C
7	D	**29**	E	**47**	A	**59**	A
8	B	**30**	C	**48**	E	**60**	B
9	A	**31**	C	**49**	D		
10	E	**32**	D	**50**	B		
11	E	**33**	E	**51**	A		
12	A	**34**	B	**52**	A		
13	D	**35**	A				
14	A	**36**	E				
15	C	**37**	C				
16	B	**38**	D				
17	E	**39**	A				
18	D	**40**	C				
19	D						
20	D						
21	B						
22	E						

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MOCK PAPER A ANSWERS

Question 1: A

The Dolomite Mountains are located in south-eastern Italy, part of the Southern Limestone Alps.

Question 2: B

The Marriage of Figaro is an opera by Amadeus Mozart who lived in the 18th century. Of the other possible answers, only Beethoven was Mozart's contemporary. Chopin, Rimsky-Korsakov, and Tchaikovsky are all 19th century composers.

Question 3: A

The Aztec capital of Tenochtitlan, once the largest city on earth, was in what is now Mexico. The Mayans were also in southern Mexico, and in Central America. The Inca were based in Peru.

Question 4: B

Vermeer painted *Girl with a Pearl Earring*. Only Vermeer, Rembrandt and Van Gogh were Dutch. Vermeer and Rembrandt were contemporaries during the Dutch Golden Age.

Question 5: E

This great speech is spoken by Mark Anthony at Caesar's funeral in Julius Caesar. The speech is meant to antagonise a crowd of onlookers against Caesar's murderers.

Question 6: C

Charlemagne united large parts of France, Germany, and Northern Italy, and then had himself declared Emperor of the Romans by the pope, on Christmas day in 800 AD. Of the possible answers, only Charles the Bald was also a Holy Roman Emperor.

Question 7: C

The Harlem Renaissance was an African-American artistic movement, Harlem is a borough of New York city.

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Question 8: B
The Knights Hospitaller, also known as the Knights of St John, ruled Malta. Cyprus was briefly ruled by the Knights Templar, another chivalric order, whose job of protecting pilgrims had become defunct.

Question 9: E
Margaret Thatcher resigned in 1990, John Major was her successor.

Question 10: A
Io and Europa are two of Jupiter's many moons. They are, along with many of Jupiter's other moons, named after the deity's various lovers.

Question 11: A
FARC is a Marxist movement formed during the cold war. The Shining Path are also a Marxists Latin American Group, based in Peru. ETA is a Basque separatist movement.

Question 12: C
The Metamorphoses was written by Ovid; Ovid, Virgil and Horace were all part of the Golden Age of Latin literature. Virgil was his contemporary and wrote the Aeneid. Horace wrote various Odes and Satires. Dante was writing in Medieval Italy and Homer, if he really existed, was Greek.

Question 13: E
The question can be expressed as $(40 \times 30) - x(50 \times 30) = 200 = 1{,}200 - 1{,}500x$. Therefore, $x = 2/3$.

Question 14: A
As the largest digit on the number pad is 9, even if 9 was pressed for an infinitely long time the entered code would still average out at no larger than 9. Therefore, it would be impossible to achieve a reference number larger than 9. Indeed, this is an extremely insecure safe but not for the reason described in **B** (for if the same incorrect number was pressed indefinitely, it would never average out as the correct one) but rather because the safe could in theory be opened with a single digit.

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Question 15: D

A is incorrect as it ignores the section of the text that states the evolution of resistant strains is driven by the presence of antibiotics themselves. The text states that the rate of bacterial reproduction is a large contributing factor and therefore not wholly responsible – hence **B** is incorrect. Since this is just one example, (and only the information in the text should be considered for these questions) for **C** to make such a general statement is completely unjustified. **D** is correct as the passage explains how antibiotic use can contribute to the development of resistance, then states that initiatives are in place to limit prescriptions, suggesting that antibiotics were indeed used frivolously.

Question 16: B

The fastest way to solve this question is to calculate the quantity of cheese per portion as 200/10 = 20. This means 350 people would require 350 x 20 = 7000g or 7kg of cheese.

Question 17: C

Calculate the calorific content of 12 portions as 12 x 300 = 3,600 kcal. As this represents 120%, evaluate what the initial amount would be as (3,600/120) x 100 = 3,000 kcal.

Question 18: B

Begin by calculating the initial weight of all the ingredients in the Bolognese sauce, which comes to a total of 3.05 kg. Therefore, when cooking for 10 people, 3.05 x 4 = 12.2 kg of pasta should be used. This means for 30 people 3 x 12.2 = 36.6 kg of pasta should be used.

Question 19: D

Calculate the new weight of ingredients in the Bolognese sauce, excluding garlic and pancetta, which produces a total of 2.8 kg. Note that onions represent 0.3 kg per 10 people and as such the ratio can be represented as 0.3/2.8, or alternatively dividing top and bottom by 0.3 to give 1/9.3

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Question 20: E

Begin with calculating total preparation time as 25 x 4 = 100 mins. The fact that Simon can only cook 8 portions at a time is somewhat of a red herring as it doesn't impact the calculation. Total cooking time can be calculated as a further 25 x 8 = 200 mins. This produces a total time of 300 mins, or 5 hours.

Question 21: C

The simplest solution is to calculate the total area at the start as 20 x 20 = 400 cm^2. Then, recognise that with every fold the area will be reduced by half, so the area will decrease as follows: 400, 200, 100, 50, 25, 12.5 – requiring a total of 5 folds.

Question 22: B

Of the 50% carrying the parasite, 20% are symptomatic. Therefore, 0.5 x 0.2 = 10% of the total population are infected and symptomatic, of which 0.1 x 0.9 = 9% are male.

Question 23: A

An organ is defined as being comprised of multiple tissue types. As blood and skeletal muscle are tissues, they cannot be classified as organs.

Question 24: E

This question is best considered in terms of the aerobic respiration equation. With that in mind, it becomes apparent that increased forward drive through the reaction will produce large amounts of water and CO_2 whilst demanding an increased supply of O_2. Further from this equation, we realise that aerobic respiration produces large amounts of heat, and as such it is expected – in the interest of thermoregulation – that the body will both perspire and vasodilate in attempt to increase heat loss. Therefore, **E** is the correct answer.

Question 25: D

Recall that the nephron is the smallest functional unit of the kidney. The question, therefore, is asking you what the smallest functional unit of striated muscle is, to which the answer is the sarcomere. Note that a myofibril is a collection of many sarcomeres and is therefore not the correct answer.

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Question 26: B

Insulin is a polypeptide hormone released by the pancreas in response to elevated plasma glucose levels. Therefore, it can be expected that plasma glucose concentration will be proportional to the concentration of insulin in the blood. Furthermore, recall that glucagon also released by the pancreas mobilises glucose stores. Therefore, the greatest concentration of plasma glucose would be expected at the time when glucagon is highest during a period of elevated insulin.

Question 27: D

Answers **A** and **C** are both nonsense and can be eliminated straight away. You will know from your study of the immune system that it is plasma B cells that produce antibodies, and that plasma T cells do not exist. Also recall that an immune response can be mounted as quickly as within a fortnight which leaves the only correct answer as **D**. The passage states that only once blood types are mixed is the immune response initiated, therefore, **D** provides an explanation as to how this happens but also why the first-born child is unaffected.

Question 28: D

An organ consists of many cell types, which once differentiated, are committed to that single cell line. Therefore, a totipotent stem cell is required to produce the multiple cell types required. To ensure that the organ is an exact genetic match, stem cells from the individual in question must be used. Unless that individual is an embryo, adult stem cells must be used

Question 29: B

Natural selection favours those who are best suited for survival – this can mean faster and stronger organisms, but not always. For example, snails are pervasive, despite being weak and slow. Variation can arise due to both genetic and environmental components.

Question 30: E

The enzyme amylase catalyses the breakdown of starch into sugars in the mouth (**1**) and the small intestine (**5**).

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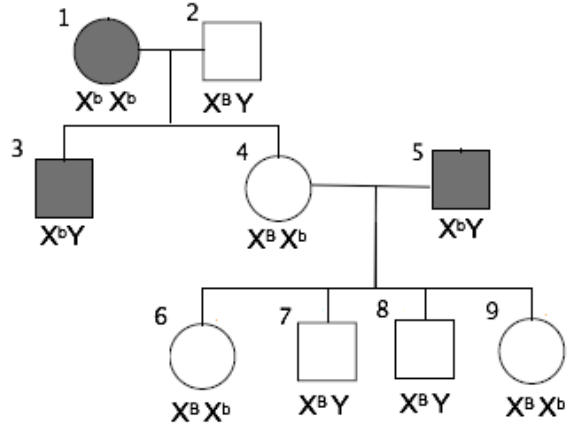
Question 31: E

Whilst there is some enzymatic digestion in **1** and **3**, the vast majority occurs in the small intestine (**5**). The liver facilitates digestion via the production of bile, and the large intestine is primarily responsible for the absorption of water.

Question 32: A

Replotting the genetic diagram with genotype information produces the diagram:



If squares were female, all of **5's** circular male offspring would be affected. Circles must be females, so **1** must be homozygous recessive, and **4** heterozygous.

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Question 33: D

The genotype of a heterozygote female is $X^B X^b$, and the genotype of 8 is $X^B Y$. Plotting the information in a Punnett square:

		Female Heterozygote	
		X^B	X^b
Individual 8 (Unaffected Male)	X^B	X^BX^B	X^BX^b
	Y	X^BY	X^bY

The offspring are 25% X^BX^B (homozygous normal female), 25% X^BX^b (heterozygous carrier female), 25% X^BY (normal male) and 25% X^bY (affected male). So, the chance of producing a colour-blind boy is 25%.

Question 34: B

As the known parent has both recessive genotypes, it can only have the gametes y and t. The next generation has a phenotypic ratio of 1:1:1:1. As both recessive and dominant traits are present in the progeny, the unknown parent's genotype must contain both the recessive and dominant alleles. Hence the unknown parent's genotype must be YyTt, as this would produce the gamete combinations of YT, Yt, yT and yt, which when combined with the known yt gametes would result in YyTt, Yytt, yyTt and yytt in equal ratios.

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Question 35: D

The possible genotypes are:

- YYTT (yellow, tall)
- YyTT (yellow, tall)
- yyTT (green, tall)
- YYTt (yellow, tall)
- YYtt (yellow, short)
- YyTt (yellow, tall)
- Yytt (yellow, short)
- yyTt (green, tall)
- yytt (green, short).

Thus, 9 different genotypes and 4 different phenotypes are possible.

Question 36: B

HCO_3^- is the conjugate base of carbonic acid. If the pH of the blood drops, the bicarbonate molecule will accept an H^+ ion. It is not bound to protein and exists freely in the plasma. The normal pH of arterial blood is not exactly neutral, but very slightly alkaline, between 7.38 and 7.42.

Question 37: A

The diaphragm is crucial to breathing, as during inhalation it contracts and expands the chest space, along with the intercostal muscles which draw the ribs upwards and outwards, effectively lowering the pressure within the thoracic cavity and drawing air into the lungs. During exhalation, all the muscles relax, which lets the ribs drop downwards and inwards and the diaphragm balloons upwards into the chest space. This increases the pressure within the thoracic cavity, which forces air out of the lungs.

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Question 38: E

Like the pulmonary circulation, the umbilical artery and vein is the only other example where a vein carries oxygenated blood and the artery carries deoxygenated blood. Veins carry blood to the heart, so the umbilical vein carries oxygenated blood from the mother to the foetus' heart, and the umbilical artery carries deoxygenated blood away from the foetus' heart to the mother.

Question 39: E

The kidneys are involved in ultrafiltration as they filter all the blood in the body of toxins and waste products from metabolic reactions. The waste is released as urine via the bladder. Some of the water is filtered out then reabsorbed by the kidney, especially when the body is dehydrated. Although glucose is reabsorbed by the kidney, it does not play a part in glucose regulation as that is mainly done by the pancreas through secretion of insulin and glucagon. These hormones are two of many found in the body, none of which are produced by the kidneys. There are some that are produced by the adrenal cortices that sit atop the kidneys, but these are a separate anatomical structure from the kidney.

Question 40: A

Haemophilia B is an X-linked recessive disorder which means you need two copies of the faulty genes in girls to present the phenotype associated with the disease and only one copy in males as they have XY chromosomes and are thus missing the extra X chromosome which may have carried the healthy, dominant gene. As Mike, the father of the baby girl, is not affected, we can assume that the mother carries one copy of the faulty gene herself. Thus, although the baby girl will not be affected by the condition, she may be a carrier of the gene and so, can pass it on to future generations.

Question 41: E

Recall that pH is a logarithmic scale of proton concentration and therefore will have the largest effect on hydrogen bonding.

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Question 42: B

Isotopes of an element all contain the same number of protons but a different number of neutrons. As atomic number refers solely to the number of protons it will not change. However, as mass number is the sum of atomic number and neutron number, it would be expected to change. The number of electrons in an isotype is also unaffected, as neutrons do not affect charge. Chemical properties are the same for all isotopes. Therefore, the correct answer is **B**.

Question 43: B

The transition metals are the most abundant catalysts – presumably due to their ability to achieve a variable number of stable states. Therefore, the correct answer is the d-block elements.

Question 44: E

Begin by writing down the balanced equation that describes the reaction of francium with water:

$$2Fr + 2H_2O \rightarrow 2FrOH + H_2.$$

Next calculate the moles of francium entering the reaction as 1338/223 = 6.

We now know from the stoichiometry of the equation that this reaction will produce 3 moles of hydrogen. Recall that 1 mole of gas at room temperature and pressure occupies 24dm^3. Therefore, the hydrogen produced in this reaction will occupy 3 x 24 = 72 dm^3.

Question 45: D

The test for the presence of hydrogen gas is to listen for the squeaky pop. **A** indicates oxygen, **B** carbon dioxide, **C** chlorine gas and **E** is not a test for any gas in particular.

Question 46: C

Helen is wrong; carbon dioxide is produced. Remember that when a metal carbonate reacts with an acid, water, carbon dioxide and a salt are produced.

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Question 47: B

The calculation in this question is simple: concentration = mass/volume. What this question is really testing is the manipulation of unorthodox units. Begin by noting the use of g/dL in the final answers and therefore begin by converting the quantities in the question into these units.

1.2×10^{10} kg = 1.2×10^{13} g

With 10 decilitres in a litre, 4×10^{12} L = 4×10^{13} dL.

$\frac{(1.2 \times 10^{13})}{(4 \times 10^{13})} = 3 \times 10^{-1}$ g/dL.

Question 48: A

A catalyst is not essential for the progression of a chemical reaction, it only acts to lower the activation energy and therefore increase the likelihood and rate of a reaction.

Question 49: E

Cationic surfactants represent a class of molecule that demonstrates both hydrophilic and hydrophobic domains. This allows it to act as an emulsifying agent, which is particularly useful in the disruption of grease or lipid deposits. Therefore, cationic surfactants have applications in all the products listed.

Question 50: D

The hydrogen halide binds to the alkene's unsaturated double bond. This results in a fully saturated product that consists purely of covalent bonds.

Question 51: E

This is an example of an addition reaction; the fluorine and hydrogen atoms are added at the unsaturated bond. If you're unsure about this type of question, draw it out and the answer will be obvious.

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Question 52: A

All the above are true. Every mole of gas occupies the same volume. The left side, therefore, occupies 4 volumes, and the right side occupies 2 volumes. Increasing the pressure will favour the lower volume side, and so the equilibrium will shift right to produce ammonia and decrease the overall volume that the products and reactants occupy. If more N_2 gas is added, equilibrium will shift to react away this gas and lower the concentration again, with the result that more ammonia will be formed.

Question 53: B

Let tail = T, body and legs = B and head = H.
As described in the question, H = T + 0.5B and B = T + H.
We have already been told that T = 30Kg.
Therefore, substitute the second equation into the first as H = 30 + 0.5 (30 + H).

Re-arranging reveals that -0.5H = 45 Kg and therefore the weight of the head is 90 Kg, the body and legs weigh 120 Kg, and as we were told, the tail weighs 30 Kg. This gives a total weight of 240 Kg

Question 54: D

Recall that kinetic energy can be calculated as $E = 0.5mv^2$. Therefore, if mass remains constant it is the v^2 term that must be reduced to a sixteenth. In other words, $v^2 = 1/16$ and therefore the correct velocity is $1/4x$.

Question 55: B

Recall that V = E/Q.
Therefore, when substituting SI units into this equation it is discovered that $V = J/C = JC^{-1}$.

Question 56: C

Recall that voltmeters are always connected in parallel, and that because they don't draw any current from the circuit, have an infinite resistance. Ammeters, on the other hand, are connected in series and therefore must not perturb the flow of given, meaning they have zero resistance.

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Question 57: A

Much of the information in this question is not needed and is simply put there to distract you. This question can be most quickly solved using the equation F = ma, or force = mass x acceleration.

As object A is the only thing moving in this scenario, it is the only source of energy to be considered. Its mass will be the same before and after the collision and so we need only calculate the magnitude of retardation.

This is $(15 – 3)/0.5 = 24\ ms^{-2}$.

Therefore, when plugging into the first equation, we realise that F = 12 x 24 = 288 N of force was dissipated.

Alternatively, this question could be solved by calculating the rate of change of momentum.

Question 58: C

Note the atomic masses and numbers in the equation. Whilst the atomic mass has remained constant, the atomic number has increased by one and hence the element has changed. The only explanation for this is that a neutron has turned into a proton (and an electron which is represented by *x*). Therefore, the correct answer is **C** – beta radioactive decay.

Question 59: B

Begin by calculating the velocity of the wave as speed = wavelength x frequency = 3 x 20 = 60 km/s. In a period of one hour (3600s), this would equate to a total distance of 60 x 3600 = 216,000 km.

Question 60: C

The numerator of the fraction consists of 3 distinct terms or 3 distinct dimensions. As all other functions within the equation are constants, this is the volume of a complex 3D shape.

END OF PAPER

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MOCK PAPER B ANSWERS

Question 1: E

Juno went into orbit around Jupiter. Juno was Jupiter's wife in Roman mythology.

Question 2: E

The Volta River, not to be confused with the Volga, runs through West Africa. The Danube runs through Central and Eastern Europe. The Elbe runs through Germany and Czech Republic. The Seine runs through France and the Rhine through Switzerland and Germany.

Question 3: D

The American Declaration of Independence was signed in 1776. 1789 was the date of the French revolution; many French people were inspired by their American counterparts' break for freedom.

Question 4: C

Nelson Mandela was released from prison in 1990.

Question 5: D

Sometimes known as the Kyoto agreement, or Kyoto Protocol, it was signed in 1997 and implemented in 2005.

Question 6: C

Marie and her husband studied the effects of radiation, with disastrous personal consequences. She discovered both radium and polonium and won the Nobel prize twice for her work.

Question 7: C

It was Voltaire, who was widely known in Europe at the time for saying things that got him into trouble.

Question 8: E

Though Hungary was never part of Yugoslavia, many of Yugoslavia's members were previously part of the Austro-Hungarian Empire.

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Question 9: E
Clarissa was written by Samuel Richardson, not Jane Austen.

Question 10: E
Bastille day is the 14th of July, not long after American Independence Day, which is on July 4th.

Question 11: A
'Hell is other people' comes from Jean-Paul Sartre's play, No Exit, in which the characters' hell is to be trapped in a waiting room together for eternity. Of the other possible answers, only Albert Camus was a French existentialist writer, and he was, by all accounts, less misanthropic.

Question 12: C
Siddhartha was the Buddha's original name as a prince living in northern India before giving it all up to sit under the Bodhi Tree.

Question 13: A
Begin by converting all the quantities into items, as that is the terminology used on the graph axis. Therefore, 12 rugby balls = 6 items and 120 tennis balls = 24 items. Reading from the graph reveals their respective prices as £9 and £5.
Therefore, the total cost of products in the order is (6 x 9) + (24 x 5) = 174.
Since this is significantly more than £100, the delivery charge is waived.

Question 14: E
Calculate the cost of 10 of everything as (2 x 5) x (10 x 7) x (5 x 9) = £125. Recall that delivery charge is waived at £100 and this therefore a trick question and no delivery charge is applied.

Question 15: E
Tennis balls are sold in the largest pack for the cheapest price, so rugby balls and footballs are irrelevant. Tennis balls cost £5 for five if you buy 0-99, or £4 if you buy 100-499. If you bought £1000's worth at £5 each, you would have 200 packs, so 1000 balls. However, this is not correct, as when you buy £200, one pack is £4. As a result, for £1000 you can buy 250 packs, which is 1,250 balls.

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Question 16: B
Recognise that 120% profit is equivalent to 220% of the original price, in which case the initial purchase price = (1,320/220) x 100 = £600.

Question 17: A
Note that here the question uses the term item and so you can simply read the costs directly off the graph, giving a total order cost of (2 x 2000) + (4 x 2000) + (6 x 2000) = £24,000. Recall though that he only pays tax on the amount over £12,000, which in this case is £12,000.
Therefore, he pays 12,000/4 = £3,000 tax.

Question 18: C
Lucy must live between Vicky and Shannon. Lucy is Vicky's neighbour, so Shannon cannot have a red door. Vicky lives next to someone with a red door, so Lucy must have the red door. This leaves Shannon with the blue door and Lucy with the white. The green door is across the road and so does not belong to any of them.

Question 19: E
First, calculate an average complete one-way journey time as 40 + 5 + 5 = 50 minutes. Deducting his breaks, he works a total of 7 hours 20 or 440 minutes. Since the first train is already loaded, his first run will only take 45 minutes, leaving 395 minutes to complete his working day. 395/50 = 7 remainder 45. Note that 45 minutes is not enough to fully unload the train, but it is enough to load the train and drive the distance. Therefore, the driver will complete a total of 9 journeys equalling 198 miles.

Question 20: E
A is not actually a valid assumption as we do not know what proposal conservationists might be bringing to the local councils; they have only expressed their concern. They may well be bringing a proposal to ask for funding to rehome all the species in the affected environment. **B** is essential to the final paragraph whilst **C** must be assumed, otherwise the councils would not be presenting these proposals at all.

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Question 21: B

Let my current age = m and my brother's current age = g.
The first section of this question can therefore be expressed as m + 4 = 1/3(g + 1)
The second half can be represented as 2(m + 20) = g + 20.
Therefore, this problem can be solved as simultaneous equations.
Rearranged, the second equation reads m = 1/2 g – 10
When substituted into the first equation, we get 1/2 g – 10 + 4 = 1/3 (g + 1).
Expand and simplify to 1/2g – 6 = 1/3g + 1/3 → 1/6g = $6\frac{1}{3}$
Therefore, my brother's current age = $6\frac{1}{3}$ / (1/6) = 114/3 = 38.
This means that my current age = 1/2(38) – 10 = 9.

Question 22: A

150 x 100 x 10 = 150,000 cm^2
150,000 ÷ 100^3 = 0.15 m^2
Therefore, the amount of surplus volume is 60% of 0.15 m^2.
0.15 x 0.6 = 0.09 m^2.

Question 23: D

As the question states that GLUT2 is ATP independent, then active transport is instantly incorrect as it is ATP dependent. Osmosis is applicable only to water molecules and is therefore incorrect. Exocytosis refers to the movement of molecules out of a cell and is therefore incorrect. Simple diffusion is incorrect as the question states that GLUT2 is essential for the process. This leaves the correct answer of facilitated diffusion.

Question 24: E

Firstly, recall that endocytosis is a process of molecular transport into cells that result in vesicular formation. This question requires you to realise the special case of this which is phagocytosis – conducted by white blood cells in the ingestion of pathogens.

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Question 25: E

All of the above statements are true of the Calvin cycle with regards to the Krebs cycle. As the main driver of photosynthesis, we know that the Calvin cycle requires both CO_2 and light to conduct ATP dependent reactions. As opposed to the Krebs cycle in man, however, the Calvin cycle adopts the use of NADPH as the intermediate in electron transport.

Question 26: D

Option **D** is one of only 2 graphs that demonstrate a quadratic relationship with the peak enzyme activity correctly placed – pepsin from the stomach close to pH 1, and trypsin secreted by the pancreas and therefore alkaline around pH 13. The curves traced in option **C** however are far too broad over the pH range to represent enzyme activity. As the pH scale is logarithmic, even a change of 1 or 0.5 can be devastating to enzyme activity.

Question 27: A

MRSA stands for methicillin-resistant staphylococcus aureus. Methicillin is a type of antibiotic, and staphylococcus a type of bacteria. As a result, the question is really asking what antibiotic resistance is an example of. Antibiotic resistance is a common example of natural selection.

This question was taken directly from the IMAT syllabus where many examples are listed for different principles. Reading the IMAT syllabus and highlighting these is a very good idea as well as learning the definitions listed.

Question 28: C

The innate immune system refers to the parts of the immune system that are non-specific to the type of pathogen. Antibodies are not part of the innate system, as antibodies are specific for antigens. **1**, **2**, **3,** and **6** are all example of components of the innate immune system.

Question 29: C

Osmosis is the movement of water particles across a partially permeable membrane from an area of low solute concentration to an area of high solute concentration. It is not an active process as water can easily diffuse through bilipid layer membranes and thus does not require a specific passage.

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Question 30: E

Plants give off carbon via respiration and death. Although some of the carbon is given off, trees and plants do store carbon in their cells and thus they are known as carbon stores.

Question 31: D

Enzymes are always substrate specific as the active site is made up of a specific set of amino acids that determine which reaction the enzyme catalyses.

Question 32: E

Statements **1** and **3** are correct. Statement **2** is incorrect, as it is the 4-carbon molecule oxaloacetate that is regenerated. Oxaloacetate combines with acetyl CoA to form the 6-carbon citrate.

Question 33: B

Statement **1** and **3** are incorrect. Cyclic phosphorylation doesn't require water as no photolysis occurs – the electrons are just passed back to the chlorophyll molecule. Photolysis only occurs in PSII, because this is where the enzymes are. Statement **2** is correct; photolysis of water produces protons, which can reduce NADP.

Question 34: C

Statement **1** is incorrect as RUBISCO is an enzyme that fixes carbon dioxide to RuBP. Statement **2** is correct. 6 turns of the cycle produce 12 triose phosphate molecules. 10 are used to regenerate RuBP, and 2 are removed from the cycle to form one molecule of glucose.

Question 35: E

Statement **1** is correct; sodium ions drive depolarisation and potassium ions drive repolarisation. Statement **2** is correct, as hyperpolarisation prevents the initiation of another action potential in the region that has just been depolarised, so the action potential can only travel forwards. Statement **3** is correct. As temperature increases, action potentials travel faster, up to around 40°C after which the proteins start to denature. Larger diameter axons have less electrical resistance, so action potentials can travel faster.

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Question 36: E

Statement **1** is correct; if too much insulin is given then the blood glucose level can fall dangerously low. Statement **2** is incorrect; adrenaline increases blood glucose to allow the body to respond to a fight-or-flight situation. Statement **3** is correct; glucagon causes glycogen to be hydrolysed into glucose (glycogenolysis), and fatty acids and amino acids to be converted into glucose (gluconeogenesis)

Question 37: C

1 is incorrect as the primary component of the cell membrane is phospholipids, not triglycerides. **2** is also wrong as cholesterol is not a protein, but a lipid. **3** is correct, so **C** is the answer.

Question 38: C

Although unlikely, if Mr. Anderson's wife was a carrier for the Haemophilia B allele, then his children may have the disease. If she is not, then there would be none of his children would be affected, though the daughters would be carriers.

Question 39: D

The key here is to notice that four out of the six siblings are affected. This means Mr. Anderson's mother is heterozygous, as if she was homozygous, all the children would be affected. This means there is a 50% chance of producing an affected child.

Question 40: A

The main points in this question are that Haemophilia B is rare because many people who suffered from it died before they could have children. This is an example of Darwinism, where disadvantageous alleles are slowly bred out of the gene pool, and advantageous alleles (i.e. not the allele for Haemophilia B) become more common.

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Question 41: E

To answer this question, you must recall that anaerobic respiration in humans produces only lactate and energy, whilst in yeast the anaerobic respiratory process yields a molecule of ethanol and CO_2 per glucose molecule. Therefore, there will be 0 mol of CO_2 produced in the human cell culture and you need only work out the moles of CO_2 produced by the yeast cell culture to calculate the difference. There is a total of 5.76/0.18 = 32 mol of glucose, of which half is supplied to the yeast cell culture. With a stoichiometric ratio of 1:1 in the anaerobic respiration equation, a total of 16 mol of CO_2 will be produced.

Question 42: A

Initially, the electron configuration of Mg is 2,8,2. In binding to two chlorine atoms, it is effectively ionised to Mg^{2+} and loses two electrons to leave a complete outer shell, so the correct answer is 2,8.

Question 43: D

The first thing to note in this trace is that the m/z axis has been cut short. From looking up the mass of calcium in the periodic table, one would expect to see the x axis centred around 40. However, here the trace is only displaying those isotopes with valence 2, (z = 2) hence the values are half the size. Therefore, (from the periodic table) when dividing the most abundant isotope of chromium by two, 52/2 = 26, we confirm that the outlier bar on the right is indeed the contaminant. Therefore, to calculate the actual abundance of M_r 40 calcium ignore the chromium like so: 55/95 = 11/19.

Question 44: A

Begin by converting the total weight of arsenic into grams: $15 \times 10^6 = 1.5 \times 10^7$.
Then, divide by the M_r of arsenic:
$1.5 \times 10^7 \div 75 = 2 \times 10^5$
Don't forget that the sample is at worst 80% pure.
Therefore, there will be a minimum of $(2 \times 10^5) \times 0.8 = 1.6 \times 10^5$ moles of pure arsenic.

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Question 45: D

Recall that average atomic mass is calculated as the sum of (isotope mass x relative abundance). Therefore, 28 = (26 x 0.6) + (30 x 0.3) + 0.1*x*.

Rearranging this equation reveals that 0.1*x* = 3.4 and that the mystery isotope therefore has an atomic mass of 34.

Question 46: A

First, recall that when a Group 2 metal is reacted with steam a metal oxide is formed and therefore the following chemical equation can be drawn: $Mg + H_2O_{(g)} \rightarrow MgO + H_2$.

Next, calculate that there is 72/24 = 3 mol of hydrogen produced.

Therefore, assuming that there are 3 mol of all other reactants and the reaction is complete, one would expect 3 x 24.3 = 72.9 g of magnesium and 3 x 18 = 54 g of steam. This is indeed the case and therefore the reaction is complete.

Question 47: B

The reducing agent is the species which is oxidised – it reduces another species. In this instance, from looking at the oxidation states we can see that that the species is S^{2-}. This is because after the reaction has taken place, it has an oxidation state of +6, which would require a loss of negative charge i.e. electrons.

Question 48: C

The highly stable bonds between carbon atoms and between carbon and hydrogen atoms renders alkanes relatively unreactive. This is important to note, as it highlights the major difference between alkanes and alkenes.

Question 49: A

Chloride is oxidised during this process to form Cl_2. Although the first part of **2** is correct, H_2O is required to dissolve the NaCl (not H_2 which is a product of the reaction). NaOH is a strong base.

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Question 50: E

Sodium is element 11 on the periodic table, a Group 1 element, so has electron configuration 2, 8, 1. It forms a metallic bond with other sodium atoms. Chlorine is element 17 in Group 7, so has 17 electrons and 7 valence electrons, giving a configuration of 2, 8, 7. Chlorine forms the covalently-bonded gas Cl_2, sharing one electron for a full valence shell. Salt (NaCl) is an ionic compound, where sodium gives its single valence electron to chlorine so both atoms have full outer electron shells.

Question 51: C

ΔH is positive because the enthalpy of the products is higher than the enthalpy of the reactants. This also means that the reactants are less stable than the products and because it is endothermic, energy is absorbed from the surroundings.

Question 52: A

There are several methods to work this out, one of which is shown below.

Mass of FeS_2 in the ore = 480 x 0.75 = 360 kg

1 mole of FeS_2 = 55 + 32 + 32 = 119 g

This can be rounded to 120 g for ease of calculation.

Number of moles of FeS_2 in the ore = $\frac{360 \times 10^3}{120} = 3 \times 10^3$ mol

Mass of Fe = $(3 \times 10^3) \times 55 = 165$ kg.

Question 53: A

Recall that current = charge/time. The question provides both charge and time in the correct units and so the calculation is relatively simple with no unit conversions required.

Therefore, current = 5/15 = 1/3 = 0.33 A. As the question states that the balloon has a negative charge it has therefore gained electrons. Given that a current is defined as a net movement of electrons, in this situation the current must be flowing into the balloon.

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Question 54: D

Given that Power = IV it can be deduced that I = P/V. Recall that power given in Watts is a measure of the energy transferred per second and therefore has the alternative units Js^{-1}. When substituting these units into the power equation re-arranged for Amps, it is revealed that $I = (Js^{-1})/V = A$.

Question 55: D

For a transformer that is 100% efficient, power in must equal power out. Recall that P = IV. Therefore, the transformer has a power output of 24 x 10 = 240 W, which is 80% of the initial input. As such, the initial power input was (240/80) x 100 = 300 W.

Question 56: C

Begin by calculating the energy required to hoist the mass. This is calculated using the potential energy equation: mgh.

Energy = mass x g x height $\Rightarrow$ 20 x 10 x 30 = 6000 N.

The power output of the motor is calculated as the joules dissipated per second $\Rightarrow$ 6000/20 = 300W

Question 57: D

To solve this problem, recall that activity = decay constant x number of remaining atoms. Therefore, the decay constant can be calculated simply as 0.36/6 = 0.06.

Question 58: D

Recall that household electricity is available in the UK at 240 V.

Begin by calculating the wattage that the bulb is receiving as 0.5 x 240 = 120 W.

Given that the energy rating of the bulb is 80W, we can assume that this bulb is only 80/120 = 66% efficient.

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Question 59: C

The formula for calculating compound interest can be given as investment x (interest rate^{years}) or for this situation: $1687.5 = 500x^3$.

Therefore, in order to calculate the interest rate, the above formula must be rearranged to:

$\sqrt[3]{1687.5/500} = 1.5$

This gives an interest rate of 50%.

Question 60: B

Statement **1** is incorrect; the range of human hearing is 20 Hz – 20 kHz, not 20 Hz to 200 kHz. Statement **2** is correct. Statement **3** is incorrect; echoes are caused by the reflection, not refraction, of sound.

END OF PAPER

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MOCK PAPER C ANSWERS

Question 1: B

Richard Nixon was impeached for spying on his political opponents, and unusually, getting caught.

Question 2: B

Bits of the Sistine Chapel were painted by multiple painters including Botticelli, Perugino, and Ghirlandaio. The ceiling itself though, and the Creation of Adam, were painted by Michelangelo.

Question 3: A

Kosovo is the second youngest and was given independence from Serbia in 2008. South Sudan succeeded in July 2011.

Question 4: C

Florence Nightingale volunteered to work during the Crimean war, where her practice came to be greatly admired.

Question 5: E

The Bloomsbury Group writers were all living in London in the Edwardian period and experimenting with new ideas. Daniel Defoe lived much earlier and was most famous for writing Robinson Crusoe.

Question 6: C

Although all large birds, the albatross is the largest.

Question 7: E

The beer bubble is not a real bubble, although the craft beer market is rumoured to be oversaturated.

Question 8: B

The 1812 overture was written to celebrate the defeat of Napoleon in that year. The Stalingrad Symphony was given that title by the USSR and declared a celebration of the troops who fought there in WWII.

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Question 9: D
The first triumvirate was an alliance between Julius Caesar, Crassus, and Pompey Magnus. Marc Anthony and Marcus Lepidus were members of the second triumvirate, which formed after Julius Caesar's death.

Question 10: A
All these things were invented during WWII, but those scientists all worked on the Manhattan Project specifically, to build the atomic bomb.

Question 11: A
A third plane crashed into the Pentagon at the same time.

Question 12: E
Our sun is a yellow dwarf.

Question 13: A
The main conclusion is that some works of modern art no longer constitute art. **B** is not an assumption made by the author as the main conclusion does not rely on *all* modern art being ugly to be valid. **C** is not an assumption because the argument does not rely on artists studying for decades to produce pieces of work that constitute art. This point is simply used to support the main argument. Options **D** and **E** are stated in the argument so are not assumptions. **A** is an assumption because it is required to be true to support the main conclusion but is not explicitly stated in the argument.

Question 14: E
Reducing the price of the sunglasses by 10% is equivalent to multiplying the price by 0.9. The price of the sunglasses is successively reduced by 10% three times and so the price on Monday is 0.9^3 the price of the sunglasses on Friday. 0.9^3 is equal to 0.729 and so the price of the sunglasses on Monday is 72.9% of the price of the sunglasses on Friday.

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Question 15: E

Looking at the flat cube net, we can deduce that that the square and the triangle cannot be on adjacent sides, and likewise with the black circle and the white circle. However, the white circle is on an adjacent side to the square and the triangle. This leaves **D** and **E**. In **D**, the square is not oriented correctly, so it cannot be the answer.

Question 16: C

The information provided about the child needs to be inserted into the BMI formula:
$BMI = 35 \div 1.2^2$
$1.2^2 = 1.44$
It may be easier to work out 3500 divided by 144, rather than 35 divided by 1.44.
The answer needs to be worked out to 3 decimal places for an answer required to 2 decimal places.
The answer to 3 decimal places is 24.305 and so the BMI to 2 decimal places is 24.31.

Question 17: C

It is important that the information is inserted into the formula given for calculating the BMR of a woman rather than a man:
BMR = (10 x weight in kg) + (6.25 x height in cm) – (5 x age in years) – 161
BMR = (10 x 80) + (6.25 x 170) – (5 x 32) – 161
BMR = 800 + 1062.5 – 160 – 161
The BMR of the woman in the question is therefore 1541.5 kcal.

Question 18: D

This time, the information needs to be inserted into the formula for calculating the BMI of a man:
BMR = (10 x weight in kg) + (6.25 x height in cm) – (5 x age in years) + 5
BMR = (10 x 80) + (6.25 x 170) – (5 x 45) +5
BMR = 800 + 1062.5 – 225 + 5
The BMR of the man in the question is therefore 1642.5 kcal. The man does little to no exercise each week. Therefore, multiply 1642.5 by 1.2, which gives a daily recommended intake of 1971 kcal.

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Question 19: C

It is easier to write out this calculation in the following format:

a b 7 –
a b
5 6 5

From the above subtraction, b must be equal to 2 because 7 - 2 = 5, which is the unit term of the answer. It is now possible to rewrite the calculation with 2 substituted for b:

a 2 7 –
a 2
5 6 5

From the above calculation it is possible to gauge certain facts. a must be greater than 5 because 1 is carried over to the second term:

~~a~~ ^{1}2 7 –
a 2
5 6 5

It is now clear than a must be equal to 6 because 12 - 6 = 6, which is the tens value of the answer.

Question 20: E

First, count how many squares make up the shape: 12.

588 ÷ 12 = 49.

So, one square has an area of 49 cm^2.

Squares have sides of equal length, so the length of a side of one square is 7 cm.

Now, just count how many sides form the outline of the shape: 26.

7 x 26 = 182 cm.

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Question 21: D

There are three different options for staying at the hotel. They could either pay for three single rooms for £180, one single and one double room for £165, or one four-person room for £215.

Subtracting the cleaning cost for one night would leave:

£180 - (3 x £12) = £144

£165 - (2 x £12) = £141

£215 - £12 = £203

The cheapest option is one single and one double room, and they want to stay three nights, which gives £141 x 3 = £423.

Question 22: C

Firstly, construct two algebraic equations: A – 18 = B – 25 and $A = \frac{5}{6} B$.

Solve these two equations as simultaneous equations by substituting $\frac{5}{6} B$ for A in equation 1:

$\frac{5}{6} B - 18 = B - 25$

$7 = \frac{1}{6} B$

$B = 42$

Put B = 42 back into equation 2: $A = 42 \times \frac{5}{6}$

$A = 35$

Question 23: C

Statement **1** is true. High temperatures and pH extremes cause a permanent alteration to the highly specific shape of the active site so that the substrate can no longer bind, and the enzyme no longer works.

Statement **2** is false. Amylase is produced in the salivary glands, pancreas, and small intestine.

Statement **3** is true.

Statement **4** is false. Bile is stored in the gallbladder, but it does travel down the bile duct to neutralise hydrochloric acid found in the stomach.

Statement **5** is true. Fructose is sweeter than glucose, so smaller amounts can be used in food used in the slimming industry.

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Question 24: C

The combining of food with bile and digestive enzymes occurs in the duodenum of the small intestine. In the ileum of the small intestine, the digested food is absorbed into the blood and lymph. The digested food then progresses into the large intestine. In the colon, water is reabsorbed. Faeces are then stored in the rectum and leave the alimentary canal via the anus.

Question 25: C

Statement **1** is true.

Statement **2** is true. For example, the drug curare, a South American plant toxin which is used in arrow poison, stops the nerve impulse from crossing the synapse and causes paralysis and can stop breathing.

Statement **3** is false. The sheath provides insulation for the nerve axon and increases the speed of impulse transmission via saltatory conduction.

Statement **4** is false. The peripheral nervous system includes motor and sensory neurons carrying impulses between receptors, effectors, and the central nervous system. The CNS consists of the spinal cord and the brain.

Statement **5** is true. A reflex arc travels from sensory neuron to relay neuron to motor neuron and is an innate mechanism designed to keep the animal safe. For example, it allows a person to quickly draw their hand away from a flame.

Question 26: D

Statement **1** is false because the pulmonary artery carries deoxygenated blood from the right ventricle to the lungs.

Statement **2** is true. This property of the aorta allows it to carry blood at high pressure and is why it pulsates.

Statement **3** is false because the mitral valve, otherwise known as the bicuspid valve, is between the left atrium and left ventricle.

Statement **4** is true.

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Question 27: B

Statement **1** is true. Males have one X chromosome, so if the allele is present, they will be affected. Females have two X chromosomes so both need to be affected to be red-green colour blind as the condition is recessive.

Statement **2** is true because, according to the Punnett square to the right, half of the children will have the homozygous recessive tt genotype and so will be non-rollers.

	T	**t**
t	Tt	tt
t	Tt	tt

Statement **3** is true because all the male children will inherit an X chromosome from the mother, which will carry the colour-blind allele.

Question 28: E

Statement **1** is true.

Statement **2** is true. Decomposers in the soil break down urea and the bodies of dead organisms and this results in the production of ammonia.

Statement **3** is true.

Statement **4** is true.

Question 29: E

None of these statements are correct. RNA polymerase is responsible for causing the RNA nucleotides to pair with exposed nucleotides of the unwound DNA strand. It is introns – the non-coding regions – that are transcribed but not translated. Finally, protein synthesis occurs in the nucleus (transcription) and the ribosome (translation). Proteins are folded and conjugated in the Golgi apparatus.

Question 30: D

Remember that the definition of sympatric speciation is the evolution of a new species from a different species while both occupy the same geographic location. This means that if there is any geographic separation at all, allopatric or parapatric speciation occurred. The only option where there is no geographic isolation is **D**, as it suggests that a higher frequency of sound could lead to reproductive isolation, and eventually sympatric speciation.

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Question 31: A

A is correct – the concentration of LH is indeed highest during ovulation. Menstruation occurs in the follicular, not the luteal, phase. FSH and LH are released from the pituitary and progesterone is released from the corpus luteum of the ovary. Falling levels of FSH and LH after ovulation cause an increase in progesterone. FSH and LH stimulate follicle development – oestrogen is responsible for thickening the endometrium, thinning the cervical mucus, and inhibiting LH production.

Question 32: C

Glucose, in a healthy person, is reabsorbed in the proximal convoluted tubule. It is co-transported with sodium by a transport protein present in the cell membranes of the cells lining the PCT. In patients with diabetes, there may be too much glucose present in the blood to reabsorb, so it is excreted in the urine.

Question 33: B

Statements **2** and **3** are both correct. Statement **1** is not, as it is pyruvate that is converted into lactic acid, and pyruvate is a 3-carbon compound.

Question 34: B

A. Interphase
B. Prophase
C. Anaphase
D. Telophase
E. Metaphase

Question 35: **E**

When writing a karyotype, the number refers to the number of chromosomes the individual has, and the letters refer to their sex chromosomes. A male is usually born with XY chromosomes, so Andrew, with an extra X chromosome, will be XXY. Most people have 46 chromosomes, but as Andrew has an extra one, his karyotype is 47,XXY.

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Question 36: C

When two heterozygotes are crossed, usually there is a 25% chance that the offspring will be homozygous dominant, 25% chance that the offspring will be homozygous recessive, and a 50% chance of heterozygosity. However, the key to this question is realising that it is impossible for the kitten to be homozygous recessive, or it would not have survived to birth. Therefore, the answer is 33%, as there are only two possible genotypes, not three.

Question 37: E

None of these statements are correct. Hypertension does increase the risk of a heart attack, but it causes hypertrophy (thickening) of the ventricle walls. Lifestyle changes are one of the most effective measures when trying to improve cardiovascular health – losing weight, stopping smoking and lowering your LDL ("bad" cholesterol) levels all can have significant effects. Statins do improve cardiovascular health, but they work by reducing the LDL levels in the blood, not by directly reducing blood pressure.

Question 38: D

E. coli, or *Escherichia coli* in full, is a Gram-negative bacterium, not a virus.

Question 39: B

Pluripotent stem cells are embryonic stem cells, so they can form any cell that will form in the foetus. This means they cannot form placental epithelial cells, but they can form gametes. Totipotent cells can become cells of the placenta, as they are taken at an earlier stage.

Question 40: A

1 and **4** are examples of positive feedback, not negative. In **1**, the greater the pressure on the cervix, the more oxytocin is released, increasing the strength and frequency of contractions. In **4**, around ovulation the system switches from negative feedback to positive feedback, where high levels of oestrogen cause LH and FSH levels to rise, promoting further follicle development.

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Question 41: C

Statement **1** is true.

Statement **2** is false. The transition metals are both malleable and ductile, they conduct heat and electricity, and they form positive ions when reacted with non-metals.

Statement **3** is true. Thermal decomposition is a reaction whereby a substance breaks down into two or more other substances due to heat. When a transition metal carbonate is heated, metal oxide and carbon dioxide are produced. The carbon dioxide can be collected and will turn limewater cloudy. An example of this reaction is: $CuCO_3 \rightarrow CuO + CO_2$

Statement **4** is false. Transition metal hydroxides are insoluble in water.

Statement **5** is true.

Question 42: D

There are 9 sulphur atoms on the left so there must be 9 on the right. Therefore, the values of **B** and **C** must add to make 9. This can be written as an equation: **B** + **C** = 9

It is now useful to try to balance the oxygen atoms: 4**A** + 36 = 10 + 4**B** + 4**C** + 14

Simplify to give: 12 = 4**B** + 4**C** - 4**A**

Equation 1 can now be substituted into equation 2 to give: 12 = (4 x 9) - 4**A**

24 = 4**A** →**A** = 6

There are 6 potassium atoms on the left. This means that there must also be 6 potassium atoms on the right, so **B** must by 3. As shown in equation 1, **B** and **C** add to make 9 so **C** must be 6.

5 $PhCH_3$ + **6** $KMnO_4$ + **9** H_2SO_4 = **5** $PhCOOH$ + **3** K_2SO_4 + **6** $MnSO_4$ + **14** H_2O

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Question 43: A

This question requires the use of c = n/v where c = concentration, n = moles and v = volume.

Convert 25cm^3 into litres to get 0.025 litres and plug the values for concentration and volume into the equation to get the number of moles: $0.1 = \frac{n}{0.025}$ so n = 0.0025

This question also requires the use of the equation $n = \frac{m}{Mr}$ where m = mass, n = moles and M_r = molecular mass.

The molecular mass is the sum of one calcium and two chlorine atoms which is equal to 111 gmol^{-1}.

Inserting the molecular mass and number of moles into the above equation gives the mass of calcium chloride: m = 0.0025 x 111 = 0.28g

Question 44: E

Percentage yield = $\frac{\text{actual yield (g)}}{\text{predicted yield (g)}}$ x 100.

If all the benzene was converted to product (100 percent yield), then 20.5 g of nitrobenzene would be produced: 13 g C_6H_6 x $\frac{1 \text{ mol } C_6H_6}{78 \text{ g } C_6H_6}$ x $\frac{123 \text{ g } C_6H_5NO_2}{1 \text{ mol } C_6H_5NO_2}$ = 20.5 g $C_6H_5NO_2$.

However, only 16.4g are produced. Using the equation, we can now calculate the percentage yield:

$\frac{16.4 \text{ g}}{20.5 \text{ g}}$ x 100 = 80% yield.

Question 45: B

The question is asking for which of the statements are *false*.

Statement **1** is true.

Statement **2** is true.

Statement **3** is false. Ionic compounds do conduct electricity when dissolved in water or when melted because the ions can move and carry current. On the other hand, solid ionic compounds do not conduct electricity.

Statement **4** is true. Alloys contain different sized atoms, making it harder for the layers of atoms to slide over each other.

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Question 46: D

The A_r of carbon is 12, hydrogen is 1 and oxygen is 16. Therefore, 12 g of carbon is 1 mole of carbon; 2 g of H is 2 moles of hydrogen and 16 g of O is 1 mole of oxygen. The empirical formula is therefore CH_2O. The molecular weight is 30 $gmol^{-1}$, which goes into 120 $gmol^{-1}$ exactly 4 times. The empirical formula must therefore be multiplied by 4 to obtain the molecular formula, so the molecular formula is $C_4H_8O_4$.

Question 47: C

Statement **1** is true.

Statement **2** is false. The melting and boiling points increase as you go down the group.

Statement **3** is true.

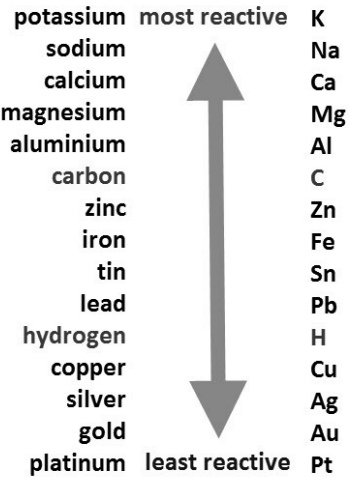
Statement **4** is false. Chloride is more reactive than bromine, so no displacement reaction occurs.

Statement **5** is true.

Question 48: B

Here, it is important to remember the reactivity series.

This is important as it tells you which elements can displace other elements in redox reactions. In this example, zinc is the only element above iron in the series and thus, is the only element that would be able to displace iron.



Question 49: A

Adding aqueous silver nitrate is a test for the presence of halide ions. If a cream precipitate forms, that suggests bromide ions are present. A lilac flame indicates the presence of potassium, so Leon has potassium bromide.

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Question 50: A

The atomic number is 32, so germanium has 32 protons. It is an atom, not an ion, so it has the same number of electrons.

Question 51: C

This is complete combustion as all the methane is used to make water and carbon dioxide. It is an aerobic reaction as oxygen is present and needed to cause the combustion of the fuel. By increasing the carbon dioxide in the system, you would either slow down or not affect the rate of combustion, but it definitely would not speed it up. This also applies to removing oxygen from the system.

Question 52: B

Only statement **2** is correct. Carboxylic acids can react with alcohols to form esters, but an acid catalyst is required, not a nickel one. They are formed through the oxidation of a primary acid (first by forming an aldehyde, then a carboxylic acid). The oxidation of a secondary alcohol produces a ketone instead.

Question 53: B

Start by multiplying each term by ax to give: $a(y + x) = x^2 + a^2$.

Expand the brackets: $ay + ax = x^2 + a^2$

Subtract ax from both sides: $ay = x^2 + a^2 - ax$

Lastly, divide the both sides by a to get: $y = \frac{x^2 + a^2 - ax}{a}$.

Question 54: C

Solve as simultaneous equations. Start by substituting $x = \frac{y}{3}$ into equation B.

This gives $y = \frac{18}{y} - 7$

Multiply every term by y to give:

$0 = y^2 + 7y - 18$

Factorise this quadratic to give:

$0 = (y + 9)(y - 2)$

Where the graphs meet, y is equal to 2 and 9.

Then $y = 3x$, so the graphs meet when $x = 6$ and $x = 27$

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Question 55: B

To win one game, Rupert must win one squash game and one tennis game. To calculate the probability of winning one game, it is necessary to add the probability of winning one tennis game and losing one squash game to the probability of losing one tennis game and winning one squash game.

$(\frac{3}{4} \times \frac{2}{3}) + (\frac{1}{4} \times \frac{1}{3}) = \frac{7}{12}$

Question 56: C

The numbers can all be written as a fraction over 36:

- $0.\dot{3}$ is the same as $\frac{12}{36}$
- $\frac{11}{18}$ is the same as $\frac{22}{36}$
- 0.25 is the same as $\frac{9}{36}$
- 0.75 is the same as $\frac{27}{36}$
- $\frac{62}{72}$ is the same as $\frac{31}{36}$
- $\frac{7}{7}$ is the same as $\frac{36}{36}$

Ordering them from lowest to highest gives: $\frac{7}{36}$; 0.25; $0.\dot{3}$; $\frac{11}{18}$; 0.75; $\frac{62}{72}$; $\frac{7}{7}$

Therefore, the median value is $\frac{11}{18}$.

Question 57: B

This question requires the use of the equation p = mv where p = momentum, m = mass and v = velocity.

The total momentum before the collision is equal to the sum of the momentum of carriage 1 (12000 x 5) and carriage 2 (8000 x 0), which is 60,000 kg ms^{-1}.

Momentum is conserved before and after the collision so the total momentum after the event also equals 60,000 kg ms^{-1}.

The carriages now move together, so the combined mass is 20,000kg.

Using the equation again, the total momentum (60,000 kg ms^{-1}) divided by the total mass (20,000 kg) gives the velocity of the train carriages after the crash, which is equal to 3 ms^{-1}.

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Question 58: C

Statement **1** is true.

Statement **2** is false because infrared has a longer wavelength than visible light.

Statement **3** is true.

Statement **4** is false because gamma radiation, not infrared radiation, is used to sterilise food and to kill cancer cells.

Statement **5** is true because darker skins contain a higher amount of melanin pigment, which absorbs UV light.

Question 59: C

Statement **1** is false. In a nuclear reactor, uranium nuclei split to release energy and three neutrons. An explosion could occur if all the neutrons are absorbed by further uranium nuclei as the reaction would escalate out of control. Control rods that are made of boron absorb some of the neutrons and control the chain reaction.

Statement **2** is false. Nuclear fusion occurs when a deuterium and tritium nucleus are forced together. The nuclei both carry a positive charge and consequently very high temperatures and pressures are required to overcome the electrostatic repulsion. These temperatures and pressures are expensive and hard to repeat and so fusion is not currently suitable as a source of energy.

Statement **3** is true.

Statement **4** is true. During beta decay, a neutron transforms into a proton and an electron. The proton remains in the nucleus, whereas the electron is emitted and is referred to as a beta particle. The carbon-14 nucleus now has gained a proton and lost a neutron, so the atomic number goes up 1 while the mass number is unchanged.

Statement **5** is false. Beta particles ionise more than gamma and less than alpha.

Question 60: E

Firstly, deal with the term in the brackets: $3^3 = 27$

$(x^{½})^3 = x^{1.5}$

$(3x^{½})^3 = 27x^{1.5}$

Next, divide by $3x^2$: $\frac{27}{3} = 9$

$\frac{x^{1.5}}{x^2} = x^{-0.5} = \frac{1}{\sqrt{x}}$

$9 \times \frac{1}{\sqrt{x}} = \frac{9}{\sqrt{x}}$

END OF PAPER

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MOCK PAPER D ANSWERS

Question 1: C

Mason and Dixon surveyed the north-eastern corner of the United States to end a border dispute. Symbolically, the line became the border between the North and South in the dispute over slavery.

Question 2: D

Franz Kafka was a German-speaking Jew living in Prague.

Question 3: C

Mansa Musa ruled the Malian empire, whose gold mines made him absurdly wealthy.

Question 4: B

Japan occupied Manchuria, to universal outcry. In China, the invasion of Manchuria is considered to mark the beginnings of the Second World War.

Question 5: B

Isabella and Ferdinand united Spain through both their marriage, and by waging war on the Muslim population in the south. They finally took Grenada in 1492.

Question 6: A

The Doppler effect.

Question 7: D

Hurricane Katrina hit Florida, Louisiana, and the Gulf Coast, flooding large parts of New Orleans.

Question 8: A

Mens Rea is Latin for guilty mind.

Question 9: C

China hosted the Olympics in Beijing in 2008, London, UK in 2012, and Rio de Janeiro, Brazil in 2016. The 2020 Olympic Games should have been held in Tokyo, Japan.

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Question 10: B
Scientists cloned five identical monkeys. Dolly, the first cloned sheep, was born in 1996 and cows were first cloned in Japan in 1998.

Question 11: A
No Country for Old Men was written by Cormac McCarthy.

Question 12: A
Although many of George Orwell's' writings deal with freedom and authority as themes, the word newspeak is only used in 1984 to denote the policing of language.

Question 13: C
The initial argument suggests that two things must be present for an action to happen. If only one is absent, the action cannot happen. Argument **C** has the same form, the others do not.

Question 14: E
Building model ships requires several positive traits. The passage does not tell us which the most important or most commonly lacked skill is, only that more than one skill is required for success.

Question 15: C
Joseph does not have blue cubic blocks, since all his blue blocks are cylindrical.

Question 16: B
The chance of red is 2/6 = 1/3. To get no reds at all, it must be non-red for each of three independent rolls. The probability of this is $(2/3)^3 = 8/27$.
Therefore, the probability of at least one red is $1 - 8/27 = \underline{19/27}$

Question 17: D
These three furniture items are compatible with having 6 legs. All the other statements are false.

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Question 18: D
Work this out by time. The friends are closing on each other at a total of 6 mph overall, therefore the 42 miles take 7 hours. In seven hours, the falcon, flying at 18 mph, covers 18 x 7 = 126 miles.

Question 19: C
The passage tells us that antibiotic resistance could lead to people dying from Victorian diseases, and that liberal use of antibiotics in farming is the "most significant" contributor to this. Therefore, it would be true to say that this use of antibiotics could cause serious harm.

Question 20: B
Calculate the overall cost of three stationery sets, then subtract any items not bought. For each item shared between two people there is one of that item not required. The overall cost is £6.00 per person, or £18.00 overall. Subtract one geometry set (£3), one paper pad (£1) and one pencil (50p) to give an overall cost of £13.50

Question 21: B
James runs 26.2 seconds, which is outside the qualifying time, therefore he does not qualify. All we know about Steven and Joe is that they ran faster than James.

Question 22: D
Using s as the sandwich price, c for the crisps and w for the watermelon, the equation to solve is: £5.60 = s + c + w.
Substituting in the following information: w = 2s and s = 2c
£5.60 = s + 2s + $\frac{s}{2}$ or £5.60 = 3.5s
s = £1.60
Hence, w = 2 x £1.60 = £3.20

Question 23: E
Haemoglobin is contained within red blood cells and is not free in the blood. Additionally, as a protein, it is too large to normally pass through the glomerular filtration barrier. All the other substances are freely filtered.

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Question 24: B

In order for the membrane potential to become more positive, there must be a net movement of positive ions into the muscle cell (so it becomes more positive compared to its resting state). Since there is a greater concentration of sodium ions outside, more sodium than potassium must move inwards.

Question 25: E

A polymer consists of repeating monomeric subunits. Polythene consists of multiple ethenes; glycogen of glucose; collagen of amino acids, starch of glucose; DNA of nucleotide bases, but triglycerides are not composed of monomeric subunits.

Question 26: E

Increased ADH causes more water reabsorption. This concentrates the sodium in the urine by reducing urine volume. In the healthy kidney, all the glucose is reabsorbed and none is excreted into the urine.

Question 27: D

Diastole is the relaxation phase of the cardiac cycle. In diastole, the pressure in the aorta decreases as the contractile force from the ventricles is reduced. All the other statements are true; the aortic valve closes after ventricular systole. All four chambers of the heart have blood in them throughout the cardiac cycle. The mitral valve (or the bicuspid valve) is open during diastole.

Question 28: A

The correct answer is **A**. Statements **B** and **D** describe type II diabetes, and **C** and **E** are wrong.

Question 29: B

In diabetes, the blood glucose concentration can be so high that the glucose channels in the cells of the proximal convoluted tubule are completely overwhelmed, so not all the glucose molecules can be reabsorbed. This means the solute concentration in the urine travelling through the nephron is higher than normal, so less water leaves the tubule by osmosis. This increases the volume of urine that enters the bladder, so the patient has to urinate more. **D** is also true, but it is not the best description, as it ignores the main physiological reason for frequent urination in diabetes.

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Question 30: B

Statements **1** and **3** are both correct. **2** is incorrect, as glucagon is secreted from pancreatic alpha cells – gamma cells actually secrete pancreatic polypeptide, a protein that regulates pancreatic secretion and liver glycogen storage. Knowledge about pancreatic polypeptide is outside the scope of the IMAT, but you should know that glucagon is secreted from alpha cells.

Question 31: A

Only **1** is correct. **2** is incorrect, as there is actually a rich network of capillaries around the alveoli, not arterioles and venules (although these do lead to and from capillaries). **3** is also wrong; though the alveoli walls are moist, not all of the oxygen that enters the lung can be exchanged – the percentage of oxygen in exhaled air is actually about 16%.

Question 32: B

Competitive inhibition occurs when the inhibitor prevents a reaction by binding to the enzyme active site. Hence, a higher concentration of the substrate can result in the same overall rate of reaction. i.e. the substrate outcompetes the competitor.

Non-competitive inhibition is where the inhibitor binds to the enzyme (not at the active site) and prevents the reaction from taking place. Increasing the substrate concentration therefore does not increase the reaction rate. The substrate cannot outcompete the competitor as the enzymes are disabled and the competitor is not binding to the active site.

In this graph, line **1** shows the normal reaction without inhibition, line **2** shows competitive inhibition and line **3** shows non-competitive inhibition.

Question 33: E

Nucleic acids are only found in the nucleus (DNA & RNA) and cytoplasm (RNA). They are not a component of the plasma membrane, whereas the other molecules are.

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Question 34: D

The main artery to the lungs is the pulmonary artery, which gets blocked. The clot must therefore travel through the inferior vena cava and right side of the heart. It does not enter the superior vena cava or left (systemic) circulation.

Question 35: B

Glycogen is not a hormone; it's a polysaccharide storage product mainly found in muscle and the liver.

Question 36: D

Reflexes can be influenced by the brain. For example, if you willingly pick up a hot plate, you will be able to withstand much greater heat than if you touch it by accident and discover it is hot. Reflex actions are fast as they usually bypass the brain. Since they are mediated by nerves, they are much faster than endocrine responses. Most animals show basic reflexes like the heat-withdrawal reflex which requires both sensory and motor components.

Question 37: A

Only statement **I** is correct. 2 turns of the cycle produce 4 molecules of CO_2, and FAD is used as a reducing agent as well as NAD^+.

Question 38: B

For this question, you don't need any specific knowledge of the science behind induced pluripotent stem cells, you just need to recall the definition of pluripotent. Pluripotent stem cells are embryonic stem cells, so can form any cell type that the embryo has. This does not include the placenta, so **3** is not possible – totipotent stem cells would have to be used for that, if it is ever possible.

Question 39: E

Denaturing an enzyme refers to a change in the shape of the active site such that the substrate can no longer binds. This leaves **C** and **E** as possible answers. Of these, **E** is the better explanation.

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Question 40: C

There's a lot of information to work through in this question, so you need to be aware of shortcuts when trying to work out the mode of inheritance. Neither of Anwar's parents are affected, so at least one of them must be a carrier. This means the condition must be recessive, so the answer must be **B** or **C**. The next key bit of information is that no member of the family descended from the mother's unaffected brother has Henderson's syndrome. This indicates that an unaffected man cannot be a carrier, which indicates that the mode of inheritance is X-linked recessive.

Question 41: C

It's important to know your reactivity series as it's easy marks. Remember that potassium is more reactive than sodium, as it has a greater number of electron shells, with the outermost single electron being more loosely attracted to the nucleus because of this, and hence more likely to be lost. Following this pattern, sodium is the next most reactive and copper the least.

Question 42: E

144 ml of water is 144 g, which is the equivalent of 8 moles. 8 times Avogadro's constant gives the number of molecules present, which is 4.8×10^{24}. There are 10 protons and 10 electrons in each water molecule, hence there are 4.8×10^{25} electrons.

Question 43: E

Write the equation to calculate molar ratios:

$C_8H_{18} + 12.5\ O_2 \rightarrow 8CO_2 + 9H_2O$

Travelling 10 miles uses: $228 \times 10 = 2{,}280$ g of octane.

M_r of octane = $12 \times 8 + 18 \times 1 = 114$

Number of moles of octane used = 2,280/114 = 20 moles. Thus, 160 moles of CO_2 must be produced.

M_r of CO_2 = $12 + 16 \times 2 = 44$

Mass of CO_2 produced = $44 \times 160 = 7{,}040$ g = <u>7.04 kg</u>

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Question 44: A

Lithium – crimson
Sodium – yellow-orange
Potassium – lilac
Calcium – red-orange
Copper - green

This is one of the few types of question in chemistry that relies solely on factual recall. Fortunately, the five metals of the question should be the only metals that are asked about in questions involving flame tests.

Question 45: B

Complete combustion is the reaction of a substance with oxygen to produce carbon dioxide and water. If there is insufficient oxygen, then incomplete combustion occurs, producing carbon or carbon monoxide instead of carbon dioxide. This has occurred in **C** and **E**. Only **B** is an example of complete combustion, so is the answer.

Question 46: C

The structural formula for the monomer is $HOCH_2CH(CH_3)COOH$. You can see clearly that this is a carboxylic acid with an alcohol group on the other end to facilitate ester bond formation. This means it is not a ketone, ruling out **A** and **E**. The CH_3 is a methyl group, so the straight carbon chain is composed of three carbons, so it is propanoic, not butanoic, acid. This leaves **C** and **D**. The carboxylic acid functional group (-COOH) is always attached to carbon 1, so the alcohol group, which has the prefix hydroxy, is attached to carbon three, leaving **C** as the answer.

Question 47: B

First, write out the reaction equation:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

Next, calculate the number of moles of sulfuric acid:

$n(H_2SO_4) = \frac{20}{1000} \times 0.25 = 0.005$

Two moles of sodium hydroxide are required for every mole of sulfuric acid, so the number of moles of sodium hydroxide is:

$n(NaOH) = 0.005 \times 2 = 0.01$

Therefore, the concentration of sodium hydroxide is:

$[NaOH] = 0.01 \div \frac{50}{1000} = 0.01 \div 0.05 = 0.01 \times 20 = 0.200$ mol dm^{-3}

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Question 48: D

The concentration of hydrogen ions can be calculated from a given pH using the formula:

$$[H^+] = 10^{-pH}$$

Therefore, the answer is given by:

$\frac{10^{-2}}{10^{-8}} = 10^{-2-(-8)} = 10^6 = 1{,}000{,}000.$

Question 49: C

Only **3** is true. Many addition reactions of alkenes do not require catalysts, but the reaction of an alkene with hydrogen requires a nickel catalyst. **2** is incorrect as bromine water changes from brown to colourless, not the other way around.

Question 50: E

E is correct. As the chain length decreases:

- Boiling point decreases
- Volatility and flammability increase

Question 51: A

Only statement **1** is true. Statement **2** is incorrect; like acidic buffer solutions, alkaline buffer solutions are made from a weak base and its salt. **3** is also wrong as the definition of a buffer solution is a solution that resists changes in pH when small amounts of acid or alkali are added to it – it can be overwhelmed if a large quantity is added.

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Question 52: D

First, divide the masses given in the question by the molar masses of the elements:

9 ÷ 12 = 0.75
2 ÷ 1 = 2
4 ÷ 16 = 0.25

Next, divide everything by 0.25 to get the molar ratio:

0.75 ÷ 0.25 = 3
2 ÷ 0.25 = 8
0.25 ÷ 0.25 = 1

So, the empirical formula is C_3H_8O.

The only option that has this as the empirical or molecular formula is propanol, so is the answer.

Question 53: B

Equate the volume with the surface area in the proportion instructed by the question. $3(^4/_3\pi r^3) = 4\ \pi r^2$, simplifies to $r = 1$.

Question 54: B

Gravitational potential energy increases as the grain is lifted further from floor. This is equal to the work done against gravity to attain the higher position. The potential energy is equal to $mg\Delta h$, so it is dependent upon the mass of the grain that is lifted.

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Question 55: E

This is a tricky question that requires a conceptual leap. Only the top candidates will get this correct.

Surface area of Earth $= 4\pi r^2$

$= 4 \times 3 \times (0.6 \times 10^7)^2$

$= 12 \times (6 \times 10^6)^2$

$= 12 \times 36 \times 10^{12}$

$= 3.6 \times 10^{14}$

Since pressure $= \frac{\text{Force}}{\text{Area}}$, atmospheric pressure $= \frac{\text{Force exerted by atmosphere}}{\text{Surface area of Earth}}$

Therefore: force $= 10^5 \times 3.6 \times 10^{14} = 3.6 \times 10^{19}$ N

The force exerted by the atmosphere is equal to its weight therefore:

Force = weight = mass x g

Hence, atmospheric mass $= \frac{3.6 \times 10^{19}}{10} = 3.6 \times 10^{18}$ kg

Question 56: D

F = ma; therefore, the difference in force is equal to $m_1a_1 - m_2a_2$. This equals (6 x 6) – (2 x 8) = 20 N.

Question 57: B

Number of annual flights = flights per hour x number of hours in one year x number of air

$= 4 \times (24 \times 365) \times 1000$

$= 96 \times 365 \times (1000)$

$\approx 100 \times 365 \times 10 \times 100$

$= 365 \times 10^5 = 36.5$ Million

However, this is an overestimate as we have multiplied by 100 instead of 96. Hence, the actual answer will be slightly lower. 35 million is the only other viable option available.

Question 58: A

Because the two sides of the circuit are in parallel, both sets of lights experience a 24 V voltage drop across them. In lights **R** and **S**, this is shared equally between them, but in lights **P** and **Q**, the new light with twice the resistance takes twice the voltage in accordance with Ohm's Law (V= IR).

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Question 59: D

Add the first and last equations together to give: 2F = 4, thus F = 2.
Then add the second and third equations to give 2F – 2H = 5. Thus, H = -0.5
Finally, substitute back in to the first equation to give 2 + G – 0.5 = 1. Thus, G = -0.5
Therefore, FGH = 2 x -0.5 x -0.5 = 0.5.

Question 60: E

This is a simple recall question. X-rays have the shortest wavelength, whilst microwaves have the longest, with visible light being somewhere in the middle. It is well worth your time remembering the basic positions of the components of the electromagnetic spectrum, as it frequently gets tested in the IMAT.

END OF PAPER

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MOCK PAPER E ANSWERS

Question 1: B

Sao Paolo, Rio De Janeiro, and Brasilia are all important Brazilian cities. Brasilia was made the administrative Capital of Brazil. It was planned and built in the 1950s to replace Rio De Janeiro.

Question 2: C

Although all are notable German thinkers, Marx and Engels wrote the Communist Manifesto.

Question 3: A

While all these islands had early Greek settlements on them, Crete was home to the Minoan civilisation – one of the oldest civilisations on Earth, with its own distinctive culture and art style.

Question 4: C

Named after the medieval friar William of Occam, and still an important principle today in science and philosophy, Occam's Razor states that, 'All things being equal, given two possible explanations the simplest is preferred.'

Example: If a glass of water is knocked over when I am not home, I could deduce it was either my cat, or ghosts. The best explanation is that my cat did it, as it does not require me to explain what ghosts are, why I think they exist, how they can knock things overly with their ghostly hands etc.

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Question 5: B
Wordsworth, Keats, and Byron were all Romantic poets; John Donne and Shakespeare belong to the Elizabethan period. Wordsworth is sometimes considered one of the founders of Romanticism, a great admirer of nature.

I wandered lonely as a cloud
That floats on high o'er vales and hills,
When all at once I saw a crowd,-
A host, of golden daffodils;
Beside the lake, beneath the trees,
Fluttering and dancing in the breeze.

Question 6: A
Henry Kissinger was awarded the Nobel Peace Prize in 1973, causing several committee members to resign in protest.

Question 7: A
The British Labour party was formed in 1900 amid growing concern for labour rights worldwide. The Whigs and Conservative parties are far older. The Green party has its origins in the People's Party, formed in 1972, and the Liberal Democrats were formed in the 1980's by a merger between the SDP and the Liberal Party.

Question 8: E
The Motherboard is the central component of a computer. It has some alternative names including Mainboard, Logicboard and Systemboard. Megatron is the nemesis of Optimus Prime in the original Transformers cartoon series.

Question 9: C
Nelson was a very famous admiral by the time of his death at the battle of Trafalgar. Waterloo was a decisive land battle during the Napoleonic wars.

Question 10: A
Having been shown a prototype of an Apple computer, in 1976 Steve Jobs founded Apple Computers. Steve Jobs also founded Pixar in 1986, acquiring the graphics division of Lucasfilm Ltd and renaming it.

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Question 11: A
The famous Cogito, I think therefore I am, was written by Rene Descartes in his Meditations, in which he tried to establish what it was possible to know for certain.

Question 12: B
All these countries except Czechia, which uses the koruna, use the euro as their currency.

Question 13: C
Tom arrives at 16:20 and leaves 45 minutes after Jane leaves. Therefore, he also leaves 45 mins after Hannah leaves, since Jane and Hannah leave together. Since his journey is 10 mins faster than Hannah's, he arrives only 35 minutes after Hannah arrives (which happens to be 16:20). Therefore, Hannah arrives 35 minutes earlier than this, at 15:45. Since she left at 14:30, her journey took 75 minutes. Jane's journey took 40% longer (1.4 x 75 = 105 minutes). Therefore, leaving at the same time as Hannah, 14:30, Jane arrived 105 minutes later at 16:15.

Question 14: B
This is a simultaneous equations question. Let x be the number of standard tickets sold, and y be the number of premium tickets sold.
Therefore: $x + y = 600$; $10x + 16y = 6{,}600$
$x = 600 - y$
Substitute: $10(600 - y) + 16y = 6600$
$6y = 600$
$y = 100$, therefore 100 premium tickets were sold.

Question 15: C
Between 20th January and 23rd May, there are 123 days. In 123 days, the moon makes 123/28 = 4.39 orbits. This is equal to 4.39 x 360° = 1580°

Question 16: E
You are looking for a strong opposition to the proposition that students at drama academies are not taught well academically. The strongest opposition would be evidence that such students perform academically well in some objective measure. Evidence of significantly above average GCSE results provides this.

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Question 17: D
You should definitely draw this one out on paper. Trace out the paths and you find that both people have a net displacement of 11km to the north. Therefore, since Anil is only net 2 km east, and Suresh is 17 km east of the starting point, there is a 15 km separation between them

Question 18: A
Walking at 4 mph, 3 miles takes ¾ hour = 45 mins. Adding the 5-minute stop, Chris will arrive at 18:20, since he set off at 17:30. At 24 mph, 6 miles takes ¼ hour = 15 mins. Therefore, setting off at 18:10, Sarah will arrive at Laura's at 18:25. Therefore, Chris arrives 5 minutes earlier than Sarah.

Question 19: D
The passage tells us that illegal downloads are causing harm to the music industry. Whilst it gives an example, this does not mean the stated example is the principal issue. The conclusion that best fits the passage as a whole is to say illegal downloading is more harmful than many people think, given their willingness to undertake it.

Question 20: E
First, calculate the amount of water needed for each type of fire.
Use x as the amount of water used to extinguish a house fire.
40,000L = 2x, so x = 20,000 L.
Then, take y as the amount of water needed to extinguish a garden fire.
70,000 L = 2x + 3y. 30,000 L = 3y, y = 10,000 L.
Knowing this, **A** is correct, **B** is correct, **C** is correct and **D** is correct. Only **E** is false.
Three house and ten garden fires require 160,000 litres to extinguish, not 140,000.

Question 21: D
The passage only talks about people's opinions on the scheme, and not about any action which could potentially be taken. Therefore, the best summary is to say that more people oppose the scheme than support it.

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Question 22: D
The suggestion is made that reducing wild fishing will improve fish populations. This assertion carries two major assumptions – that the fishing originally caused the decline, and that the decline is reversible, and can therefore recover if the threat is removed.

Question 23: E
E is wrong – insulin, not glucagon, is released in response to feeding.

Question 24: D
Blood flow to the kidneys is constant - not exercise dependent. Overall, cardiac output increases since heart rate and stroke volume increase (because there is greater oxygen demand from exercising muscle). There is more blood flow to the muscles to fuel them and to the skin to help lose excess heat. Blood flow to the gut decreases to increase availability to muscles. Blood flow to vital organs such as the kidney and brain remains constant.

Question 25: A
Since A-T and C-G are the DNA base pairings, 29.6% adenine implies 29.6% thymine as well. Therefore, the remaining 100 – 59.2 = 40.8% is shared between guanine and cytosine equally, so there is 20.4% cytosine.

Question 26: C
Since CO binds to the oxygen binding site of haemoglobin, it reduces oxygen binding and therefore oxygen carrying capacity of blood. Hence, the blood becomes less oxygenated. Since more blood needs to flow to deliver the same amount of oxygen, this must be accomplished by an increased in heart rate. Haemoglobin does not become heavier as the CO binds **instead** of oxygen rather than in **addition** to. Carbon dioxide is carried in plasma so is unaffected by carbon monoxide poisoning which affects haemoglobin.

Question 27: E
The most effective method in minimising side effects would be to only target bacteria. Only bacteria have a flagellum.

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Question 28: F

Structure A is the right semi-lunar valve, the pulmonary valve. It opens in systole to allow flow of blood from the right ventricle into the pulmonary artery and to the lungs. It closes in diastole to ensure the right ventricle fills only from the right atrium, maintaining a one-way flow of blood. Therefore, **E** is true; it opens when the right ventricle is emptying. None of the other statements are true.

Question 29: E

E is the correct sequence. Remember, sensory neurons take sensory information to the brain, and motor neurons take information away.

Question 30: B

Intra-thoracic volume must decrease during expiration. Thus, the intercostal muscles relax, causing the ribs to move down and in. The diaphragm moves up as well.

Question 31: D

Insulin is released from beta cells of the pancreas, not alpha cells. After a meal, carbohydrate digestion by amylase releases a lot of glucose, so if insulin was not released, the blood glucose level could become too high. Insulin reduces the blood glucose concentration by a few mechanisms, one of which being the conversion of glucose to glycogen.

Question 32: D

Being obese and having a family history of type II diabetes both increase your risk of developing the condition. However, being of white European origin is not a risk factor – in fact, type II diabetes is more common in people of South Asian and Black African descent.

Question 33: C

First, you need to take the insulin gene from a human cell. You do this with a restriction enzyme, not DNA ligase. Next, cut into the bacterial plasmid using the same restriction enzyme to produce complementary sticky ends. Finally, insert the insulin gene into the plasmid using DNA ligase.

Question 34: E

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Water is formed twice in aerobic respiration: for the first-time during glycolysis, and for the second during oxidative phosphorylation. No water is formed in the Krebs cycle – CO_2 is formed when the 5-carbon compound is oxidised.

Question 35: E

E is correct. Lipase breaks down lipids into fatty acids and glycerol, proteases break down proteins into amino acids and amylase breaks down starch specifically into glucose. Amylase is a type of carbohydrase. Bile is not an enzyme, and it emulsifies lipid droplets to increase the surface area over which lipases can work.

Question 36: B

DNA methylation suppresses gene transcription by preventing transcription factors from binding. However, histone acylation does promote gene transcription by preventing the histones from binding DNA too tightly and making it harder for the transcription factors to access the DNA. Not all genes that are present in the DNA code are transcribed. For example, there is no point in a neurone transcribing the gene for insulin!

Question 37: A

Bacterial antibiotic resistance is a common example of Darwin's theory of natural selection. It illustrates how a random, yet advantageous, mutation can grow in frequency until it is the most common allele in a given population.

Question 38: A

Only statement **I** is correct. The T wave represents the repolarisation, and therefore the relaxation, of the ventricles. An arrythmia occurs when the heart's rhythm is irregular. If the heart rate is too slow then the patient is in bradycardia, and if it is too fast, the patient is in tachycardia.

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Question 39: D

There are temperature receptors in the hypothalamus to monitor the temperature of the blood, but there are also receptors in the skin to monitor external temperature. As external temperature will change before body temperature, the first response to a change is voluntary – i.e. deciding to put a jumper on if cold. Blood plasma maintains body temperature and helps resist fluctuations – it does not cool the body. When too cold, the erector pili muscles (small muscles in the skin that raise and lower body hair) actually contract, not relax. This leaves **D** as the answer.

Question 40: C

The liver is a very large organ, often making up about 5% of a person's body mass, but is located more towards the right side of the body than the left. It sits just underneath the diaphragm. It is an important organ for the storage of glycogen, not glucagon – make sure you pay attention to the small differences! It is where urea is created, so **C** is the answer.

Question 41: E

Recall that reduction is the gain of electrons whilst oxidation is a loss. Only iodine is gaining electrons and so shows reduction.

Question 42: E

To balance the equation, start working from what you're given: the oxygen.
Since you know there are 15 oxygen atoms on the right, there must be the same on the left.
Therefore, **w** = 5.
You also know that there are 30 hydrogen atoms on the right-hand side, and so you can work out x.
30 - 5 leaves 25 atoms unaccounted for, so x = 25.

Question 43: D

Divide the percentages by the A_r of each element:
41.4 ÷ 12 = 3.45
55.2 ÷ 16 = 3.45
3.45 ÷ 1 = 3.45
This means the empirical formula is CHO, so **D** is the answer.

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Question 44: B

The trick in this question is to conserve your units to prevent silly mistakes from creeping in. 200 cm^{-3} = 0.2 dm^{-3}

Number of moles = concentration x volume so: 0.2 x 1.8 = 0.36 mol

Question 45: E

Group 6 elements are non-metals whilst Group 3 elements are metals. Thus, the Group 3 element must lose electrons when it reacts with the Group 6 element. The donation of electrons from its outer shell will decrease atomic size.

Question 46: B

Reactivity of both Group 1 and 2 increases as you go down the groups because the valence electrons that react are further away from the positively charged nucleus (which means the electrostatic attraction between them is weaker). Group 1 metals are usually more reactive because they only need to donate one electron, whilst Group 2 metals must donate two electrons.

Question 47: B

First, write down the electron configuration of all the ions and elements given:

1. Br^-: 2, 8, 8, 8
2. Ar: 2, 8, 8
3. Ca^{2+}: 2, 8, 8
4. K^{2+}: 2, 8, 8, 1
5. Na^-: 2, 8, 2

So, **2** and **3** are the same, and **B** is the answer.

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Question 48: A

First, write out the reaction equation:

$$HCl + NaOH \rightarrow H_2O + NaCl$$

Next, calculate the number of moles of HCl that are present:
n(HCl) = 60/1000 x 0.3 = 0.018 mol
So, there are also 0.018 mol of NaOH present.
Use this to calculate the concentration:
0.018 ÷ 40/1000
= 0.018 x 1000/40
= 0.018 x 25
= 0.45 mol dm^{-3}

Question 49: C

From the previous question, we know that there are 0.018 moles of both hydrochloric acid and of sodium hydroxide, so there must be 0.018 moles of water present after the reaction has occurred. The number of water molecules will be given by the number of moles multiplied by Avogadro's number.
$0.018 \times 6 \times 10^{23} = 0.108 \times 10^{23} = 1.08 \times 10^{22}$.

Question 50: D

The reaction of an alkene with a hydrogen halide is an addition reaction, as no elements or groups are substituted – the hydrogen and the halogen are simply added to the double bond. Electrophiles are electron acceptors and nucleophiles are electron donators. Here, the HCl acts as an electrophile, so the answer is electrophilic addition.

Question 51: C

If bubbles are produced in a solution, then that indicates that a gas has been produced. Lime water turns cloudy when shaken with carbon dioxide. This means CO_2 was released when dilute acid was added to a salt, suggesting that the salt is a carbonate. A blue precipitate forming on the addition of sodium hydroxide indicates the presence of copper ions. This means the solution is copper carbonate, or $CuCO_3$.

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Question 52: C

When an alcohol reacts with sodium, hydrogen and a sodium alkoxide salt is formed. Therefore, when butanol reacts with sodium, the products are sodium butoxide and hydrogen. Sodium butanoate would be the salt formed from the reaction of sodium and butanoic acid.

Question 53: B

Firstly, convert litres to m^3: 950 litres = 0.95 m^3
Buoyancy Force = Volume x Density x g.
= 0.95 x 1000 x 10 = 9,500 N
Weight of the boat = mg = 600 x 10 = 6,000 N
Since buoyancy force > weight, the boat will float.
The difference between buoyancy Force + weight = 9500 – 6000 = 3,500 N
Hence, adding mass of 350 kg (= 3,500 N as *g* is 10) will balance both forces.
Adding further mass will cause the boat to sink. Hence, the answer is 355 kg (350 kg won't cause sinking – merely balance the force).

Question 54: A

Remember that you can separate the vertical and horizontal components of both bullets. Both bullets have zero vertical velocity at t = 0. Thus, only gravity affects them – and it does so equally. Therefore, rather counter-intuitively, they hit the floor at the same time.

Question 55: C

You don't need to know the mass of the fish for this one, since there is no acceleration or deceleration taking place. The resistive forces are equivalent to the force of thrust of the fish.
Recall that work done = force x distance.
Travelling at $2ms^{-1}$, the fish travels 60 seconds x 60 minutes x 2 ms^{-1} = 7200 m in one hour.
Therefore, the work done against resistive forces is f x d = 2 N x 7200 = <u>14,400 J</u>

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Question 56: D

A moment of force = force x perpendicular distance to pivot

If the lifting arm is a uniform 5 m long, the weight exerts 2000 x 10 x 5 = 100,000 Nm of torque.

In addition, there is a 250 x 10 x 2.5 = 6,250 Nm contribution from the weight of the beam ($\frac{5}{7}$ the mass, acting through the centre of mass of the beam).

On the other side, the remaining $\frac{2}{7}$ of the beam makes a 100 x 10 x 1 = 1,000 Nm contribution.

Therefore, the counterbalance must make a (100,000 + 6,250) – 1,000 = 105,250 Nm contribution.

As the counterbalance arm is 2 m long, this requires a weight of $\frac{105,250}{2}$ = 52,625 N weight, or a mass of 5,263 kg.

The crane's height is a distracter and not needed for this question

Question 57: B

Work out the total energy transferred - 20 x 50W =1,000W of overall power by the 20 strings of lights when on.

As W = Js^{-1}, can use the time the lights are on to find the energy used over this time period.

8pm – 6am is 10 hours, so in seconds is 10 x 60 x 60 = 36,000s.

Multiplying this by the power of all sets of lights gives the energy used as:

1000 W x 36,000 s = 36,000,000 J of energy, or 36,000 kJ.

Multiply this by 20 to account for the lights being on for 20 days: 720,000 kJ

As 100 kJ of energy costs 2p, we need to do 720,000/100 = 7,200.

Multiply this by 2p = 14,400p.

Convert to pounds by dividing by 100 = £144**.**

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Question 58: C

The formula for the sum of internal angles in a regular polygon is given by: 180 (n-2), where n is the number of sides of the polygon.

Thus: 180 (n-2) = 150 x n

180n – 360 = 150n

3n = 36

n = 12

Each side is 15cm, so the perimeter is 12 x 15cm = 180 cm.

Question 59: E

For resistors in parallel, $\frac{1}{R_T} = \frac{R_1 \times R_2 \ldots}{R_1 + R_2 \ldots}$

For the first segment: $\frac{1}{R} = \frac{1}{Z} + \frac{1}{Z} = \frac{2}{Z}$

For the second segment: $\frac{1}{R} = \frac{1}{Z} + \frac{1}{Z} + \frac{1}{Z} = \frac{3}{Z}$

For the third segment: R = Z

Thus, the total resistance is: $Z + \frac{Z}{2} + \frac{Z}{3} = 22$.

$\frac{6Z + 3Z + 2Z}{6} = 22$

$11Z = 22 \times 6$

$Z = \frac{132}{11} = 12\ M\Omega$

Question 60: B

The volume of candle burned in 0.5 hour = $0.5 \times (\pi \times 2^2) = 6\ cm^3$

$6cm^3 = 6 \times 10^{-6}\ m^3$

Since density = $\frac{mass}{volume}$, in this case, $900\ kgm^{-3} = \frac{mass}{6 \times 10^{-6}\ m^3}$.

Thus, mass burned = $900 \times 6 \times 10^{-6} = 5400 \times 10^{-6}\ kg = 5.4\ g$

The M_r of $C_{24}H_{52} = 12 \times 24 + 52 \times 1 = 340$.

Thus, the number of moles burned = $\frac{5.4}{340} = 0.016$ moles.

Total energy transferred = $0.016 \times 11{,}000$

$= 16 \times 10^{-3} \times 11 \times 10^3 = 11 \times 16$

$= 176\ kJ = 175{,}000\ J$

END OF PAPER

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MOCK PAPER F ANSWERS

Question 1: A

Oumuamua is Hawaiian for 'scout'. Io is one of Jupiter's moons, Hammurabi was an ancient king, Akua is a Hawaiian word meaning God, and Maui is one of Hawaii's main islands.

Question 2: B

Leda was seduced by Zeus as a swan. Zeus changed into many things to seduce his lovers, including a cloud. He changed into a bull to seduce another lover, Europa.

Question 3: D

Hampton Court palace was home to Cardinal Wolsey, until Henry VIII saw it and claimed it for himself. the cardinal fearing execution gave his home up. It has been used by the royal family ever since.

Question 4: C

It measures windspeed. Anemo comes from the Greek anemos, meaning wind.

Question 5: D

The Taiping rebellion was a movement in China against the ruling Qing dynasty during the mid-19th century.

Question 6: A

Charles Darwin used the Galapagos islands to study evolution directly.

Question 7: D

Although their methods were slightly different, both men invented calculus synonymously, leading to a fierce international dispute over who had been first.

Question 8: B

The Peterloo massacre occurred in Manchester when a rally for parliamentary representation was charged government cavalry. The rally had occurred in the wake of a difficult period in British history with widespread famine and unemployment.

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Question 9: A
Although the aforementioned countries are not all in the eurozone, they are all EU members apart from Switzerland, which has chosen to remain independent.

Question 10: E
The prophet Zoroaster lived and preached in Iran. He taught of one God, a heaven, a hell, and gave a code of rules. While its precise foundation date is unknown, Zoroastrianism is old enough to have influenced all the Judaeo-Christian religions.

Question 11: E
India has 22 officially recognised languages, with Hindi being the most widely spoken. Pashto is a language spoken largely in Afghanistan.

Question 12: A
John F Kennedy was in office when the Cuban missile crisis occurred in 1962. His talks with Khrushchev averted a potential catastrophe.

Question 13: D
C is completely irrelevant, so is not a flaw. **B** is not a flaw because when assessing an argument, anything that is stated (i.e. not concluded from other reasons in the passage) is accepted as true. We do not require evidence or sources for any statistics presented.

A and **E** are both claiming that something is immoral, which is thus expressing an opinion on the part of the arguer. This is not a flaw; the arguer is at liberty to claim something is immoral, and to claim that the government is morally obliged to act, and that it has not done so. Also, **E** claims that *arguably* this is the most outrageous flaw of the government – clearly expressing an opinion – which is thus not required to be supported.

However, **D** identifies a valid flaw. The argument rests on us accepting that if there were less uninsured drivers, there would be less crashes. This is not necessarily correct, so **D** is a flaw in the passage.

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Question 14: A

The sentence, 'Thus, the situation in Brazil is not applicable to the UK, and legalising gun ownership in the UK would be a bad move' gives the main conclusion of the argument and this is summarised in **A**. **B** is partially supported by the passage, but the main conclusion concerns the situation in the UK and the passage states that there is little black market in the UK. **C** is incorrect as the passage only talks about gun ownership, not violent crime more generally. **D** is not fully supported by the passage, which states only that legalising guns would result in it being *easier* for criminals to acquire guns, not that there would be a large increase in their number. **E** is not the main conclusion as it focuses on an aspect of the evidence from Brazil, rather than the main conclusion which focuses on gun legislation in the UK.

Question 15: C

Start by calculating the total surface area of the walls and the floor, ignoring the door:
$2.4 \times 2 \times 4 + (2 \times 2) = 23.2\ m^2$
The area of the door is $2 \times 0.8 = 1.6\ m^2$
$23.2 - 1.6 = 21.6\ m^2$
$21.6\ m^2 = 216{,}000\ cm^2$
The area of 1 tile is $40 \times 40 = 1600\ cm^2$
$216{,}000 \div 1600$
$= 2160 \div 16 = 540 \div 4 = 135$

Question 16: B

Let the number of minutes the journey takes be t.
Therefore, ABC charges 400 + 15t pence for the journey.
We can calculate that XYZ taxis charges 400 + (30 x 6) pence = 580 pence.
Therefore, for both journeys to cost the same, 580 = 400 + 15t.
180 = 15t, therefore t=12.
Therefore, the 6 mile journey needs to take 12 minutes. 6 miles in 12 minutes is 30 miles per hour, so the answer is **B**.

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Question 17: E

To work out this question, we need to make some simultaneous equations to relate John and Michael's money. If the amount of money John has at the start is J, and the amount that Michael has is M, we get the following equations:

J – 20 = 2 (M + 20) and J + 5 = 5 (M -5), which is simplified to:

J = 2M + 60 and J = 5M – 30.

Substituting in J to work out M gives:

2M + 60 = 5M – 30, thus 3M = 90 and M = 30.

Substituting in M = 30 to one of the equations gives:

J = 60 + 60 = 120.

Thus, J + M = 150, so the answer is **E**.

Question 18: D

Usually, bread rolls cost 30p for a pack, but if the cost per bread roll is reduced by 1p then they will cost 24p. Hence, we need to find z where 24 (z + 1) = 30z, where z is the original number of packs that could have been afforded. 24z + 24 = 30z, so 24 = 6z, so z = 4. Hence, he was originally supposed to be buying 4 packets of bread rolls, which is 6 x 4 = 24 rolls.

Question 19: D

We can first work out the rate of girls' absenteeism. First, we need to work out how many of the pupils at Heather Park Academy and Holland Wood Comprehensive are girls. Let g be the number of girls in Heather Park Academy.

0.06 (g) + 0.05 (1000 - g) = (1000) (0.056).

0.06g - 0.05g = 56 - 50.

0.01 g = 6, so g = 600.

Hence, 600 pupils at Heather Park Academy are girls.

The proportions at Holland Wood Comprehensive are the same but there are half as many pupils, so 900 pupils at the two schools combined are girls.

The average absenteeism of girls is 7%. We know that 900 of the 1100 girls have an average absenteeism rate of 6%.

Let the average absenteeism rate of girls at Hurlington Academy be r.

Then, 900 x 0.06 +200r = 0.07 x 1100.

Hence, 54 + 200r = 77.

77 - 54 = 200r. 23/200 = r so r = 0.115.

Hence, the rate of absenteeism amongst girls at Hurlington Academy is 11.5%

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Question 20: D

She needs to print 400 x 2 = 800 double sided A4 sheets, which will cost 0.01 x 2 x 1.5 = £0.03 each. The total cost of this is 800 x 0.03 = £24. She also needs to print 1500 single sided A5 sheets, costing £0.01 each, giving a total of 1500 x 0.01 = £15. Hence, the total cost is £39.

Question 21: B

We can tell the amounts for the green party and the blue party are both 1/3 of the total, and that the amount for the red party is 1/4 of the total. 1/12 is left, so the amount for the yellow party must be 1/12. Hence, the red party have 3 times the intended vote of the yellow party.

Question 22: E

In Rovers' first 3 games, they have scored 1 goal and had 8 goals scored against them. In total they scored 1 goal and had 10 goals scored against them, so they must have lost their last game against United 2-0.

In City's first 3 games, they scored 7 goals and had 3 goals scored against them. In total they scored 10 goals and had 4 goals scored against them, so they must have won their game against United 3-1.

Question 23: D

The replacement of dying, damaged, and lost cells, the growth of the embryonic cell to a multi-cellular organism, and asexual reproduction are the three main reasons why cells divide through mitosis.

Question 24: E

Blood pressure in the aorta is the highest of any vessel in the body, as blood has just been ejected from the left ventricle to go to the body. The pressure in the left ventricle (and hence the aorta) is higher than that in the right ventricle (and hence the pulmonary artery) because the pressure must be sufficient to pump to the entire body, rather than just to the lungs.

Question 25: C

A sensory receptor (**1**) senses the heat of the pan. This information is passed down the sensory neurone (**2**) through a relay neurone to the motor neurone (**4)**, which then causes the muscle (**5**) to contract, pulling the finger away.

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Question 26: C

The receptor is directly coupled to the sensory neurone, so the communication here is electrical. All information between neurones passes via synapses, which use neurotransmitters to convey the information chemically. This occurs between the sensory neurone and the relay neurone, and between the relay neurone and the motor neurone. Therefore, the answer is **C**.

Question 27: D

Statements **1** and **2** are both correct. **3** is incorrect, as hormonal contraceptives usually work by decreasing LH and FSH levels (through increasing progesterone and sometimes oestrogen), preventing ovulation and follicle development.

Question 28: D

Taking the diseased allele to be X^D and X as the normal allele, we can model the scenario in the Punnett square below:

		Carrier Mother	
		X^D	**X**
Diseased Father	**X^D**	X^DX^D	X^DX
	Y	X^DY	XY

Boys are XY and girls are XX. 50% of the boys produced would have DMD. So, the probability that both boys would have the disease is 0.5 x 0.5 = 0.25

Question 29: E

We can see from the Punnett square that the probability of having a girl with DMD is 25% (X^DX^D). The probability that both are girls with DMD is 0.25 x 0.25 = 0.125.

Question 30: C

Reading carefully, it becomes clear that not only are **A** and **C** the best explanations, but they are very similar. The only difference is that **A** refers to peptide bonds and **C** refers to hydrogen bonds, so we just need to work out which is correct. Peptide bonds are extremely strong covalent bonds, and as such the heat required to break those would be far greater than the heat required to denature an enzyme. Therefore, it makes sense that a high temperature breaks hydrogen bonds, so **C** is correct.

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Question 31: C
Chemical reactions take place in the cytoplasm, and the mitochondrion is the site for aerobic respiration releasing energy. The lack of a cell wall means that this is an animal cell.

Question 32: D
White blood cells can engulf/phagocytose pathogens in order to kill them. CO_2 is transported in the plasma, not in blood cells.

Question 33: E
Statements **2** and **3** are true. **1** is incorrect – the descending limb is water-permeable, and the ascending limb is impermeable to water, but permeable to sodium ions.

Question 34: B
Only statement **2** is correct. The link reaction occurs in the mitochondrial matrix, which pyruvate enters from the cytosol. Pyruvate is then decarboxylated and oxidised to form an acetyl group (CH_3CO) before the product combines with coenzyme A.

Question 35: A
The key bit of information here is the fact that there are pairs of chromosomes still present. This indicates that we are still in meiosis I. The chromosomes are lined up along the equator, or metaphase plate, so the cell is in metaphase I.

Question 36: E
A translocation is a type of mutation where a piece of a chromosome is reattached to another, so it is not a feature of the genetic code. Degeneracy refers to the fact one amino acid may be coded for by several codons, so if the mutation occurs in the third base, it is less likely that mutation will have a harmful effect. A non-overlapping code is also a safety feature, as if a whole codon is mutated, then it will only effect one, rather than many, amino acids.

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Question 37: C

This question relies on your knowledge of the structure of red blood cells and that mitochondria contain circular DNA. If you remember that red blood cells do not have nuclei or mitochondria, in order to make more room for haemoglobin, then you can realise that they do not have genetic material or mitochondria, so they cannot contain any circular DNA.

Question 38: D

Statements **1** and **2** are correct. **3** is not, as transcription occurs in the nucleus – translation happens at the ribosome.

Question 39: A

Only statement **1** is correct. Spermatids are formed after the second meiotic division, when primary spermatocytes divide.

Question 40: C

Statement **1** is almost correct, but it is the wrong way around; thylakoids are arranged into grana. **2** is also incorrect as it is describing the light-independent reaction, which is also known as the Calvin cycle. **3** is correct.

Question 41: A

This is an example of an addition reaction: the chloride and hydrogen atoms are added at the unsaturated bond of the but-2-ene, which is between the 2nd and the 3rd C-atom. If you're unsure about this type of question, draw it out and the answer will be obvious.

Question 42: C

The electrolysis reaction for brine is: $2NaCl + 2H_2O = 2NaOH + H_2 + Cl_2$

Thus, keeping in mind the stoichiometry of the given equation, the solution must be **C**.

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Question 43: A

If the two isotopes were in equal abundance, the A_r would be 77, half-way between the two isotope masses (the average). The A_r is 76.5 (a weighted average), one quarter of the way between the isotopes, so there must be three times as much of the lighter isotope to move the A_r closer to its mass of 76.
(0.75 x 76 + 0.25 x 78 = 76.5).

Though there is more of ^{76}X than ^{78}X, this does not necessarily imply that ^{78}X is lost through decay, as opposed to naturally less abundant from the beginning, so there is no way to know the relative stability of the isotopes.

Question 44: C

Increasing the concentration of the reactants (not products) would affect reaction rate, which can be monitored by measuring the gas volume released (proportional to molar concentration). This is the reaction for photosynthesis, which does not occur spontaneously and is endothermic.

Question 45: E

Most polymers are made up of alkenes, which are unsaturated molecules. Though addition polymerisation does not release water, condensation polymerisation does. Depending on the monomer molecule, polymers can take a variety of shapes.

Question 46: A

The formation of a white precipitate on the addition of barium chloride and dilute HCl indicates the presence of sulfate ions. A green precipitate forming when sodium hydroxide is added shows that there are Fe^{2+} ions present, so the answer is iron (II) sulfate.

Question 47: A

This is a tricky question, requiring lots of knowledge about the reactions of organic chemistry. **A** is the answer; though $NaBH_4$ and an acid catalyst can reduce an aldehyde, it cannot reduce a carboxylic acid.

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Question 48: E

Statements **2** and **3** are correct. **1** is incorrect as though the first electron affinity has a negative value, because it shows a release of energy, second electron affinities tend to have a positive value, as energy is required (due to the negative charge repelling other electrons).

Question 49: D

The first thing you should notice about this question is that the answer is to one significant figure. This means you can round numbers in your calculation – remember you do not get a calculator. Next, write out your chemical equation:

$K_2CO_3 + H_2SO_4 \rightarrow K_2SO_4 + H_2O + CO_2$

It is already balanced, so the molar ratio of reactant to product is 1:1.

Next, calculate the number of moles of potassium carbonate that reacted:

M_r (K_2CO_3) = (39 x 2) + 12 + (3 x 16) = 138

138 ÷ 35 = ~0.25 mol

Next, work out the M_r of the potassium sulfate:

M_r (K_2SO_4) = (39 x 2) + 32 + (4 x 16) = 174

This means the theoretical yield of potassium sulfate is:

0.25 x 174 = 43.5 g.

22 g was actually obtained, so the percentage yield is:

22/43.5 x 100 = ~50%.

Question 50: B

First, write out the reaction equation:

$$Ca + 2HNO_3 \rightarrow Ca(NO_3)_2 + H_2$$

Remember that at room temperature and pressure, one mole of gas occupies 24 dm^3, or 24 000 cm^3. This means the number of moles of hydrogen is:

120 ÷ 24 000 = 0.005 mol.

If the percentage yield of hydrogen is 40%, then the theoretical yield is given by:

0.005 ÷ 0.4 = 0.005 ÷ 4/10 = 0.005 x 10/4 = 0.005 x 2.5 = 0.0125 mol.

This means Anisha reacted 0.0125 mol of calcium.

The mass of calcium reacted is: 0.0125 x 40 = 0.5 g.

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Question 51: A

A disproportionation reaction is a reaction where the same element or species is both oxidised and reduced. A good tip for identifying them is to see if there are multiple products that contain an element that only appeared once as a reactant. You can see that copper, which has an oxidation number of +1 in Cu_2O, is both oxidised to copper sulfate and reduced to copper.

Question 52: A

Only statement **I** is correct. A neutralisation reaction is exothermic, not endothermic. A base with a pH of 14 will turn universal indicator solution violet – it will turn blue at a pH of around 11 or 12.

Question 53: E

This question will discriminate between students who spot short-cuts built into questions to save valuable time and those that simply dive straight in without appraising the question.

The key here is that due to the conservation of energy, all the gravitational potential energy, mgh, at the top of the ramp will be converted to kinetic energy, $\frac{1}{2}mv^2$, at the bottom.

Thus, we can calculate the final velocity using the following: $mgh = \frac{1}{2}mv^2$

Note that the mass cancels so there is no need to use the density and volume information in order to calculate mass. Hence, we get: $2gh = v^2$

$v^2 = 2 \times 10 \times 20 = 400$

Therefore, $v = 20\ ms^{-1}$

Question 54: D

Waves do not transfer mass, but their net neutral motions can interfere with each other to cause standing waves or other interference patterns. The energy of a wave depends on frequency, so waves have many different energies. Gamma rays have the highest energy for light, while visible light is lower in energy.

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Question 55: A

Multiply by the denominator to give: $(7x + 10) = (3z^2 + 2)(9x + 5)$

Partially expand brackets on right side: $(7x + 10) = 9x(3z^2 + 2) + 5(3z^2 + 2)$

Take x terms across to left side: $7x - 9x(3z^2 + 2) = 5(3z^2 + 2) - 10$

Take x outside the brackets: $x[7 - 9(3z^2 + 2)] = 5(3z^2 + 2) - 10$

Thus: $x = \frac{5(3z^2 + 2) - 10}{7 - 9(3z^2 + 2)}$

Simplify to give: $x = \frac{(15z^2)}{7 - 9(3z^2 + 2)}$.

Question 56: B

An alpha particle is a helium nucleus consisting of 2 protons and 2 neutrons. An alpha decay therefore reduces the atomic (proton) number by 2 and the mass number by 4. After a single alpha decay, the resulting proton number is 88 and the resulting mass number is 184. As this then splits in to two, the resulting element has a proton number of 44 and a mass number of 92. Gamma radiation does not alter the subatomic particle make-up of an atom.

Question 57: B

The shortest distance between points A and B is a direct line. Using Pythagoras:

The diagonal of a sports field = $\sqrt{40^2 + 30^2} = \sqrt{1{,}600 + 900} = \sqrt{2{,}500} = 50$.

The diagonal between the sports fields = $\sqrt{4^2 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$.

Thus, the shortest distance between A and B = 50 + 5 + 50 = 105 m.

Question 58: C

Let $y = 1.25 \times 10^8$. This is not necessary, but helpful, as the question can then be expressed as: $\frac{100y + 10y}{2y} = \frac{110y}{2y} = 55$

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Question 59: A

Equate *y* to give:

$2x - 1 = x^2 - 1$

$x^2 - 2x = 0$

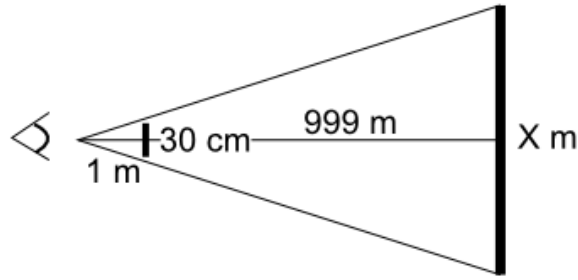
$x(x - 2) = 0$

Thus, $x = 2$ and $x = 0$

There is no need to substitute back to get the y values as only option **A** satisfies the x values.

Question 60: B

The ruler and the cruise ship look to be the same size because their edges are in line with Tim's line of sight. His eyes form the apex of two similar triangles.



All the sides of two similar triangles are in the same ratio since the angles are the same, therefore:

$$\frac{0.3\text{m}}{\text{X m}} = \frac{1\text{ m}}{1\text{ m} + 999\text{ m}}$$

Thus, $\text{X m} = 1000\text{ m} \times \frac{0.3\text{ m}}{1\text{ m}}$

$1000 \times 0.3 = 300$ m

END OF PAPER

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IMAT PAST PAPER WORKED SOLUTIONS

THE BASICS

What are IMAT Past Papers?

Thousands of students take the IMAT exam each year. These exam papers are then released online to help future students prepare for the exam. Before 2011, these papers were not publicly available meaning that students had to rely on the specimen papers and other resources for practice. However, since their release in 2011, IMAT past papers have become an invaluable resource in any student's preparation.

Where can I get IMAT Past Papers?

This book does not include IMAT past paper questions because it would be over 1,000 pages long if it did! However, all IMAT past papers since 2011 available for free from the official IMAT website. To save you the hassle of downloading lots of files, we've put them all into one easy-to-access folder for you at **https://www.uniadmissions.co.uk/book**

How should I use the IMAT Past Papers?

IMAT Past papers are the best way to prepare for the IMAT. Careful use of them can dramatically boost your scores in a short period of time. The way you use them will depend on your learning style and how much time you have until the exam date but here are some general pointers:

- 4-6 weeks of preparation is usually sufficient for most students.
- Students generally improve in the biology, chemistry, and physics and mathematics sections more quickly than section 1 so if you have limited time, focus on these.

How should I do this?

Avoid the urge to have this book open alongside a past paper you're seeing for the first time. The IMAT is difficult because of the intense time pressure it puts you under – the best way of replicating this is by doing past papers under strict exam conditions (no half measures!). Don't start out by doing past papers as this 'wastes' papers.

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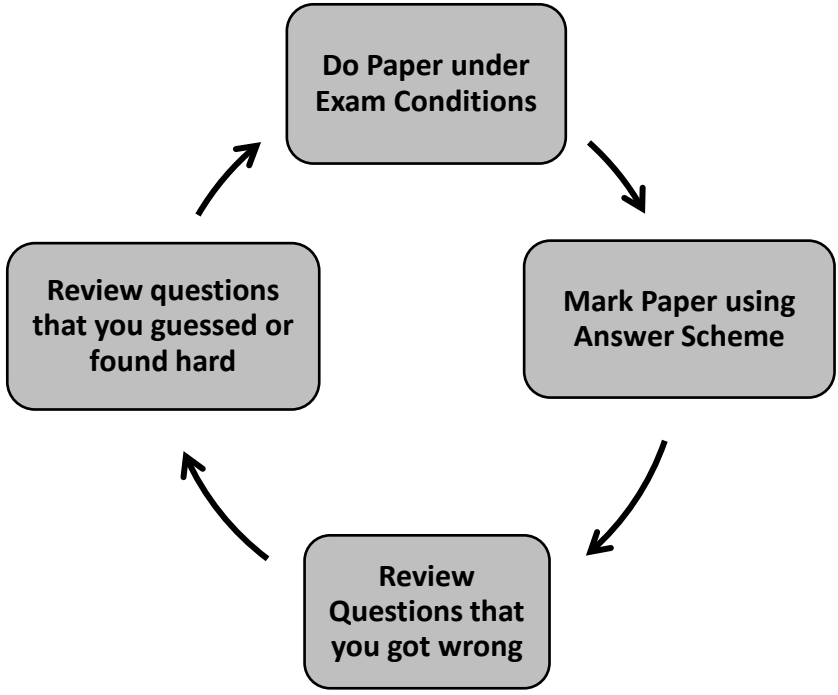
Once you've finished, take a break and then mark your answers. Then, review the questions that you got wrong followed by ones which you found tough/spent too much time on. This is the best way to learn and with practice, you should find yourself steadily improving. You should keep a track of your scores on using the tables below so you can track your progress.


Do Paper under Exam Conditions
Mark Paper using Answer Scheme
Review Questions that you got wrong
Review questions that you guessed or found hard

Scoring Tables

On the following page are tables to keep a record of your scores – you can then easily see which paper you should attempt next (always the one with the lowest score).

In practice this means setting aside two hours in an evening to find a quiet spot without interruptions and tackle the paper. Completing one mock paper every evening in the week running up to the exam would be an ideal target. Finally, relax – the IMAT is an exhausting exam and concentrating so hard continually for two hours will take its toll. So, being able to relax and switch off is essential to keep yourself sharp for exam day! Make sure you reward yourself after you finish marking your exam.

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Section 1	1st Attempt	2nd Attempt	3rd Attempt	Section 2	1st Attempt	2nd Attempt	3rd Attempt
2011				**2011**			
2012				**2012**			
2013				**2013**			
2014				**2014**			
2015				**2015**			
2016				**2016**			
2017				**2017**			
2018				**2018**			
2019				**2019**			
2020				**2020**			

Section 3	1st Attempt	2nd Attempt	3rd Attempt	Section 4	1st Attempt	2nd Attempt	3rd Attempt
2011				2011			
2012				2012			
2013				2013			
2014				2014			
2015				2015			
2016				2016			
2017				2017			
2018				2018			
2019				2019			
2020				2020			

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2011: SECTION 1

Question 1: C

There are five permanent members of the UN Security Council. These are China, France, Russia, UK and USA. There are also non-permanent members, but Japan is not included in this list either. Therefore the answer is **C**.

Question 2: C

Any potential doctor should be familiar with the Hippocratic oath. Knowing this makes this question obvious. The other options were also not physicians.

Question 3: B

Amnesty International, whilst supporting religious freedom in general, will not campaign against issues based of off theological grounds. Amnesty International clearly stands by the rest of the statements so **B** is the answer.

Question 4: D

There are 3 yellow balls left and 2 red balls left. Therefore, the answer cannot be **A** as no green ball remains. **B** is wrong as the next ball could be red. **C** is wrong as either of the next two balls could be red. **E** is wrong as all three balls could be yellow. This leaves **D** as the correct answer, which is right as if three balls are picked, the possible combinations are 1 yellow 2 red, 1 red 2 yellow, and 3 yellow. All of these combinations have at least 1 yellow ball. Another way to see this problem is that there are only 2 non-yellow balls left in the bag, so if you pick 3 out the least amount of yellow you can have is 2 non-yellow balls and a yellow ball.

Question 5: A

Instantly, the condition of no small parts rules out the jigsaw and building blocks meaning we can ignore those 2 rows. Thus, we need to find 2 toys from the car, bear and train. For 3 people to like at least one of the toys, at least one of the toys must be liked by at least 2 people. This is the bear, which is liked by Alice and Hannah. The other toy must then be liked by the person who doesn't like the bear (George) so that all the children like one of the toys. This toy is the train. All that is left is to add up the prices which is €7 + €8 = €15

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Question 6: E

From first glance the number of visitors goes up, then down, then up, then down and then down again. Thus, we can rule out **B**, **C** and **D** straight away. Now we just have to compare **A** and **E**. The difference between **A** and E is that in **A** the number of visitors at 12-2 is more than at 4-6, which is not true from the original data. So it must be **E**, which does display 12-2 as having less visitors than at 4-6 as in the data given.

Question 7: A

Polis literally means city in Greek giving away the answer rather quickly. However, you are not likely to know this, so in ancient Greece each city was rather disconnected and would rival and even wage war against each other rather frequently. This shows a system where each city oversees its own affairs. This is a city state system showing **A** to be correct.

Question 8: A

Dante is known for his tragic poetry, most famously his work the "Divine Comedy". Dante's Inferno was the first part of that work and is one of the most significant works ever written. He was born in Florence around 1265 and died in 1321. The Divine Comedy was started in 1308, but not finished for another 12 years. His family was descended from nobility, but had lost its wealth. Giulia Beccaria was an Italian noblewoman from the 18th century.

Question 9: D

The Enlightenment was a period in 18th century Europe where famous intellectuals and philosophers started to emphasise the sovereignty of reason and the evidence of the senses as sources of knowledge. It also advocated for the separation of the church and the state, equality and progress. It did identify itself with classical Greek and Roman art. The Enlightenment was centred in France, though it had far-reaching effects across Europe, and the new ideals of liberty, fraternity and equality (see the motto of France even today) paved the way for the French Revolution. The only statement that is not correct is **D**, as the Enlightenment emphasised the sovereignty of reason, not of the people and their beliefs.

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Question 10: C

Dave will pass the front gate in multiples of 8 minutes and Geoff in multiples of 15 minutes. Therefore, this is just a case of finding the lowest common multiple of 8 and 15, which is 120. This equates to 2 hours.

Question 11: A

Instantly, we can see that all the employees worked the same amount on weekday evenings and Saturdays, so we can ignore that column as it provides no extra money for any employee compared to any other employee. Then it is just a case of adding the value of the first column to twice the value in the third to find the employees overall equivalent hours at base pay worked, excluding weekday evenings and Saturdays. The employee with the highest value of equivalent hours at base pay worked excluding weekday evenings and Saturdays will have earned the most. Alice – 44, Ben – 43, Chetan – 40, Daniel – 42, Ellen – 43.

Question 12: D

The first two digits reversed all make a number between 01-12. The middle two numbers reversed are all between 11-16. The last two digits reversed in **D** are 42, and there are no months with over 31 days in them, so this cannot be the teacher's birthday, as this day does not exist.

Question 13: D

D is the only answer that is explicitly stated in the passage, the rest of the answers require a certain leap into the dark based on the information given in the passage. Also, the use of apes and crows were only used as examples, so aren't the main point of the passage making **A**, **B** and **E** incorrect. Nowhere does is say that tool use is a prerequisite for intelligence, making **C** incorrect too.

Question 14: B

Whilst the figures suggest that there may be some correlation between age of drivers and accidents, it doesn't say anywhere in the passage that the accidents involving young drivers were the fault of the young drivers. Therefore, if young drivers are taken of the road there is a chance that the number of accidents may not change, because the cause of the accidents could still be on the road.

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Question 15: D

The passage says that the problems of inaccessibility are most often solved by installing ramps, it doesn't say anywhere that this is the only solution and that a building without a ramp makes the building in question inaccessible for disabled people. Therefore, some buildings that don't have ramps will already be accessible by means of the other solutions.

Question 16: D

Building 17 is 16 houses away from number 1, so building 56 is 16 houses away from the house with the largest number, as building 1 is opposite the building with the largest number and building 17 is opposite building 56. 56 + 16 = 72. Therefore, the house with the largest number is 72.

Question 17: D

The only flights the courier can catch to do 2 round trips are the flights in the first row and then the flights in the third row, or the flights in the second row and then the flights in the fourth row. Both combinations give an overall time of 11 hours and 20 minutes. The other combination of flights overlap, and they are required to always take the next flight available so can't wait for another flight and miss one.

Question 18: E

If a is the amount of cereal in 1 pack and p is the price of 1 cereal pack, then the offers work out as follows:

- Offer 1: $\frac{3}{2}$p for 2a. Therefore p for $\frac{4}{3}$a, meaning you get an extra third of a pack for the original price
- Offer 2: $\frac{2}{3}$p for a. Therefore p for $\frac{3}{2}$a, meaning you get an extra half of a pack for the original price
- Offer 3: p for $\frac{5}{4}$a, meaning you get an extra quarter of a pack for the original price

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Question 19: B

It doesn't say anywhere that the safety at the carnival is poor and doesn't reach already reach the European regulations, so **A** and **C** can't be inferred. Something else other than safety problems may cause the carnival to not run next year, so **E** can't be concluded from the passage either. **D**, although correct, doesn't get the main point of the passage across, which is about the carnival following European regulations, so **B** is the best expression of the passage.

Question 20: A

A suggests that left-handed people actually perform better in the world than their right-handed counterparts so don't require any extra help. The rest of the answers suggest left-handed people do worse than right-handed people so do need help.

Question 21: B

Using the fact that they will react and thus move faster from stimulus, as opposed to from thought, a gunfighter will be more likely to shoot first if they react to something as opposed to thinking about shooting first, making **B** a good summary. However, the passage doesn't say they would always win via this technique, so **C** is wrong. **A** doesn't give any useful information about the passage. **E** and **D** are not mentioned in the passage.

Question 22: C

We can subtract 70c straight away as that is the tip and tells us nothing about the distance giving €9.30. The first €3.00 equates to the first 3km, leaving €6.30 spent as €0.70 per km which equates to 9km. Therefore, the overall distance is 3 + 9 = 12km

Question 23: B

Simply subtract the first column from the last column for all 5 types of station, and see which has the biggest difference:

- 245,700 – 242,300 = 3,400
- 65,700 – 37,000 = 28,700
- 400 – 500 = -100
- 5,100 – 3,900 = 1,200
- 2,000 – 1,200 = 800

The biggest difference is found in nuclear stations, so **B** is the answer.

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Question 24: D
First, vanilla is the flavour chosen by the fewest students (not joint least favourite with mint thus **A**, **C** and **E** are wrong. Vanilla is also chosen by more than half the amount of people who chose mint, so **B** must also be wrong.

Question 25: E
The passage doesn't mention anything about a pay cut, or the economy being more competitive if people were more productive, or there being less pressure on health services if a 4-day working week was implemented so **A**, **B** and **C** are not good conclusions. The passage doesn't suggest anywhere that a 4-day working week is absolutely better than a 5-day working week, just that there are benefits to a 4-day week, meaning **E** is a better conclusion than **D**.

Question 26: C
The passage refers to how important the Straits of Gibraltar are for migrating birds that cannot travel long distances in one go. If the wind farms on the hills don't pose any threat to the birds, then there is no reason that the birds can't still use their route. Therefore, **C** is an assumption on which the argument depends.

Question 27: E
Nowhere in the argument does it dispel what holding the phone next to your head when making a phone call could do, so when you do make a phone call there could still be effects, even if the phone is not near your head all the time.

Question 28: B
There are 30 days in April and 31 days in May. Thus, there are 17 days where he is the same age as his younger cousin, as you include his cousin's birthday but not his, and 19 days where he is the same age as his older cousin, as you include his birthday but not his older cousin's.

Question 29: B
Looking at the swimming participants, we can see that the ratio is roughly 3:4:6 for swimming. Therefore, we are looking for a sport with a similar ratio of participants. Bowls also has a ratio of roughly 3:4:6, therefore the answer is **B**.

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Question 30: C

1 is true – buying 3 apples leaves €1.10, which can't be made up exactly by multiples of €0.50 and €0.40. 2 is false – for instance, he can have 4 oranges meaning he has no bananas. 3 is true – the least amount of fruit he can have is 4 oranges and the most is 5 apples and 1 orange (6 pieces of fruit). He can have 5 by buying 5 bananas. 4 is true as the only combination in which he can purchase all 3 fruits is 2 apples, 1 banana and 2 oranges.

Question 31: C

This passage refers to the similarities between the fast-food industry and factories. Therefore, it is not unrealistic to compare fast food restaurants with factories and so **C** is expressed decisively in the passage. **A** and **B** are not mentioned at all. **D** and **E** can only be inferred – they are not definitely true.

Question 32: D

If the improvements are in areas that exactly match the advice given, this would suggest that the advice is in fact helping the general populous to live longer – not that the general populous knows better.

Question 33: B

Even though the average calorie intake has dropped, this is a very general statement and therefore doesn't take into account individuals very well, especially when considering the average that was used in this data. **B** is therefore a flaw in the argument.

Question 34: C

This requires use of simultaneous equations. Let Quentin's age in 2005 be Q and Peter's age in 2005 be P. By the first bit of information, $P = 4Q$, as in 2005 Peter was 4 times Quentin's age. By the second piece of information $P + 16 = 2(Q + 16)$, as in 2011 Peter is 2 times Quentin's age. Solving these equations gives Peter's age in 2005 to be 32, and Quentin's age to be 8, meaning the difference in their ages is 24.

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Question 35: D

Try to use as many small coins as possible, as their value is less, meaning more coins are used overall. Keep in mind the last digit you need to make, as with coins, making tens is easy. The combination that uses the largest number of coins is six 1c, three 2c, one 5c and two 10c coins giving twelve coins used.

Question 36: C

There will be: 50 envelopes weighing 120 – 160g, 100 envelopes weighing 160 – 250g which leaves 850 envelopes weighing 0 – 120g. This leaves an overall cost of €15.00 + €35.00 + €170.00 = €220.00.

Question 37: A

The passage expresses how laws must be written in more simple language in order for them to be more easily understood by the general public. Whilst **B** and **D** are mentioned, they are facts used to put the argument, **A**, across. **C** and **E** aren't stated clearly in the passage and can only be inferred; hence **A** is the answer.

Question 38: B

It doesn't clearly state anywhere in the passage that the advice given was not appropriate, for instance based on the facts the officials had at the time, their advice may have been completely justified.

Question 39: B

The first has length 8, then each next link provides another 4 to the total length, as the first 4 of each new link overlaps with the previous link. Therefore, if there are six chains linked together, the total length is $8 + 4 \times 5 = 28$.

Question 40: C

Let R be the number of rats and P be the number of people. Statement **1** says that $R < P$. Statement **2** says that $R \geq P$. Statement **3** says that $R \geq P$. Statement **4** says that $R \leq P$. Thus statement 2 and 3 are the same.

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SECTION 2

Question 41: A

Guanine will pair with cytosine to make up 56% of the DNA, leaving 44% for thymine and adenine, of which half of this will be thymine and half will be adenine, as they again come in a pair. Thus, 22% will be thymine.

Question 42: C

Heat is lost via the process of giving the heat energy to the water, which then evaporates off the skin, so the amount of energy required to get said water to evaporate (the latent heat of vaporisation) is most important.

Question 43: B

Each time a glucose molecule reacts with another glucose molecule a molecule of water is released, so 4 molecules of water will be released if 5 molecules react together. Hence the final chemical formula will be the total of 5 glucose molecules minus 4 water molecules. Glucose has a chemical formula of $C_6H_{12}O_6$, so $5(C_6H_{12}O_6) - 4H_2O = C_{30}H_{52}O_{26}$.

Question 44: D

Cell walls are not found in eukaryotic animal cells. DNA in loops is found in prokaryotic cells but not in animal eukaryotic cells. This is because eukaryotic DNA is present as chromosomes, therefore the answer is **D**.

Question 45: C

Mitochondria create ATP in cells, which is used to provide the cells with energy. Muscle cells require the most energy out of these cells, in order to cause contraction of the muscle. Therefore, the answer is **C.**

Question 46: E

Zygotes have the same number of chromosomes as the normal animal cell, as they are the formed by the fusion of 2 gametes which both have half the number of chromosomes of their parent cells. Meiosis creates gametes, so the daughter cell will produce half the number of original chromosomes as the parent cell. Mitosis creates an identical cell to the parent cell, so the daughter cell will have the same number of chromosomes as the parent cell.

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Question 47: C

There will have been approximately $8 \times 30 = 240$kJ of energy used to produce the ATP. Since 830kJ of energy is released when the food item is burned, the efficiency of respiration will be $\frac{240}{830} \approx 30\%$. The answer is therefore **C**.

Question 48: B

Glycolysis is where glucose (6 carbon compound) is broken down by the addition of a high-energy phosphate from ATP, which initially forms glucose 6-phosphate (phosphorylated 6 carbon compound) and then this breaks down into 2×3 carbon compounds.

Question 49: A

Sweat is not produced in muscle cells. ATP is used up during exercise. Ethanol is the product of anaerobic respiration but not in animals (lactate is produced instead). Oxygen and glycogen are used up during vigorous exercise. Therefore, the answer is **A**.

Question 50: B

There are 4 possible outcomes in this situation. Call the X chromosome that carries haemophilia X^H, then the 4 equally possible outcomes are: XY (an unaffected son), X^HY (a son with haemophilia), XX (an unaffected daughter), XX^H (a daughter who is a carrier of haemophilia). This happens as the child gets one of the X or Y chromosomes form each parent. Thus, there is a 25% chance of having a son with haemophilia and a 25% of having a carrier daughter.

Question 51: E

Q must be next to R as it is the shortest distance, P must also be next to S as it is the second shortest distance and the shortest distance doesn't involve either P or S. This leaves option **B** and **E**. We then see that P is closer to R than to Q so **E** is the option with the only combination that satisfies this additional constraint.

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Question 52: B

The possibility of AaBB is $\frac{1}{8}$, the possibility of AaBb is $\frac{1}{4}$, the possibility of aaBB is $\frac{1}{16}$, the possibility of aaBb is $\frac{1}{8}$, the possibility of AABB is $\frac{1}{16}$. This can be worked out using a 4x4 grid with the top row and first column representing the possible alleles.

	AB	**Ab**	**aB**	**ab**
AB	AABB	AABb	AaBB	AaBb
Ab	AABb	AAbb	AaBb	Aabb
aB	AaBB	AaBb	aaBB	aaBb
ab	AaBb	Aabb	aaBb	Aabb

Question 53: B

One amino acid is coded for by 3 nucleotides. There are 18 nucleotides listed, so the maximum number of amino acids is 6. However, the question asks for the number of different amino acids, and you can see that the codon CAT is repeated. This means the section shown can code for 5 different amino acids.

Question 54: A

Purine and pyrimidine bases are the base pairs - bases are found inside DNA. Pentose sugar and phosphate are found on the outside of DNA as the sugar-phosphate backbone.

Question 55: E

Natural selection is a phenomenon that leads to an organism becoming better adapted to its environment. It is caused by random mutations in all organisms, so **E** is correct.

Question 56: C

Synapses are not a part of motor neurons. This is because synapses are used to transmit an action potential between neurons. Consequently, adapting the synapse won't help the speed of transmission in a motor neuron.

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Question 57: B

During inhalation, the volume of the thorax increases since air is drawn into the lungs. This is caused by the diaphragm moving down to reduce the pressure in the thorax. Therefore, **B** is correct.

Question 58: D

The pancreas regulates the concentration of glucose in the blood, but the brain is not involved. The pancreas can detect any change in glucose concentration and can release hormones accordingly to regulate this change. Therefore, the answer is **D**.

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SECTION 3

Question 59: C

Atomic radius always decreases along a row in the Periodic Table. This is because as the atomic number increases, the forces of attraction between the protons and electrons of the atom increase, thus reducing the atomic radius.

Question 60: C

A nitrogen atom has five electrons. One electron forms a single bond to an oxygen atom, two electrons form a double bond to an oxygen atom and two electrons form a dative covalent bond to an oxygen atom.

Question 61: E

A can be done by elimination, **B** and **C** can be done by oxidation and **D** can be done by dehydration. Ethanol can form bromoethane by a simple substitution reaction, so the answer is **E**.

Question 62: A

1 is where the benzene rings which have joined now share a common side, **4** is where the two benzene rings are now attached by a carbon-carbon bond. **2**, **3** and **5** are not possible.

Question 63: E

Theoretical max yield is $\frac{64}{82} \times 8 \approx \frac{64}{80} \times 8 = 6.4$.

Therefore, yield of copper compared to theoretical maximum is:

$\frac{5.6}{6.4} = 0.875$ or 87.5% and the answer is **E**.

Question 64: E

Any noble gas is very unreactive (Ne, Kr, He) so **A**, **B** and **C** can be ruled out quickly. Elements in Group 1 are more reactive as you go down the group, whereas elements in Group 7 are more reactive as you go up. Hence Na is more reactive than Li and Cl is more reactive than Br. So, **E** will be more of an energetic reaction than **D**.

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Question 65: E

In an acid/base reaction, proton or electron pairs are donated or received. In **E**, no proton or electron pair is donated or received so it is therefore not classified as an acid/base reaction.

Question 66: C

Nitrogen has 7 electrons and hydrogen has 1; the molecule loses one electron as it has a positive charge. Therefore, the total number of electrons is:

$7 + 4 \times 1 - 1 = 10$ and the answer is C.

Question 67: B

These metals all form 3+ ions like aluminium as they are in the same group so 1 is true and 3 is false. Boron is the least reactive as elements generally get more reactive down this group.

Question 68: E

The – the number of moles of sodium chloride in the solution is given by $\frac{36}{58.5}$, the amount of solution in ml is given by $\frac{100+36}{1.13}$, therefore the amount of solution in litres is given by, $\frac{136}{1.13\times1000}$. Thus, the solubility in moles per litre is $\frac{36\times1.13\times1000}{58.5\times136}$.

Question 69: D

In D all of the elements' oxidation states remain the same throughout the reaction. Therefore no oxidation or reduction reaction has taken place to produce $NaHSO_4$ and HCl from NaCl and H_2SO_4, and the answer is D.

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SECTION 4

Question 70: D

There is no force acting on the ball that is proportional to its displacement from its equilibrium position. In fact, arguably there is no equilibrium position in this case either.

Question 71: D

Anti-Clockwise moments around the pivot equal clockwise moments around the pivot.

Thus, $1.5 \times 200 + 0.5 \times 1000 = 0.5 \times x$, where x is the weight required to balance the bar. Thus, $x = 1600$ N

Question 72: B

The higher the temperature, the more energy particles have and therefore the more entropy. At 25,000 km in space, the temperature will be very close to absolute zero, giving an entropy very close to zero.

Question 73: E

You could create an equation calculating the current at different levels of resistance, but there is an easier way. Remember that V = IR (Voltage is the product of the current and resistance). The voltage here is 20, so the product of the current and resistance must also be 20. This means when the resistance is 5 Ω, the current must be 4 A. The only graphs that fit this condition are **B** and **E**.

At the start (when the variable resistor is at 0), the total resistance is given by: $\frac{1}{\frac{1}{10}+\frac{1}{5}} = \frac{10}{3}$.

Therefore, $20 = I\left(\frac{10}{3}\right)$

So I = 6 when the resistance of the variable resistor = 0.

This means the y-intercept is 6, so **E** is the answer.

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Question 74: A

For the object to just float in the first scenario the object must have volume $\frac{50}{2.5} = 20$ ml. The mass of the water displaced in the second scenario therefore is $20 \times 2.0 = 40$ g. Therefore, the buoyancy experienced by the object from the water is 0.4 N. This makes the apparent weight of the object felt by the bottom of the container $\frac{50}{1000} \times 10 - 0.4 = 0.1$ N

Question 75: B

In this question, you need to calculate the magnitude of the answer – simply work out the correct power of 10, don't get bogged down trying to divide awkward fractions!

$$F = \frac{7 \times 10^{-11} \times 6 \times 10^{24} \times 7 \times 10^{22}}{(4 \times 10^{8})^{2}}$$

$$F = \frac{294 \times 10^{35}}{16 \times 10^{16}} \approx \frac{300 \times 10^{35}}{20 \times 10^{16}} \approx \frac{300}{20} \times \frac{10^{35}}{10^{16}} \approx 15 \times 10^{19} \approx 1.5 \times 10^{20}$$

Question 76: C

There are two ways David picks out a star at the end:

1. He moves a star from box A to box B and then picks out a star from box B.
2. He doesn't move a star from box A to box B and then picks out a star from box B.

The chance of moving a star from box A to box B is $\frac{2}{3}$, and then if a star is moved from box A to box B the chance of picking a star out of box B is $\frac{3}{4}$, giving a probability of this path of $\frac{1}{2}$. The chance a star is not moved from box A to box B is $\frac{1}{3}$, and then the chance of picking out a star of box B is $\frac{1}{2}$, giving a probability of this path of $\frac{1}{6}$. Thus, the probability David picks out a star is $\frac{1}{2} + \frac{1}{6} = \frac{2}{3}$

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Question 77: A

As the denominator of a fraction approaches 0, the value of the fraction approaches infinity. This means A or D will have the largest value for the range given, as only they will approach infinity for $0 < x < 1$. All we need to do now is work out which one is larger. For $0 < x < 1$, $\sqrt{x} > x$. As the largest value of $1/x$ or $1/\sqrt{x}$ will occur when the denominator is smaller. $1/x$ will be larger than $1/\sqrt{x}$ when $0 < x < 1$.

Question 78: D

If x is an integer satisfying the conditions in the question, then either $2\sqrt{x} - 7 < 1$ giving $x < 16$, or $7 - 2\sqrt{x} < 1$ giving $x > 9$. This leaves 6 values x can take, making $n = 6$.

Question 79: C

Because the dashed line is a bisector, it will go through (4, 2), the midpoint of A and B.

Next, work out the gradient of line AB:

m (AB) = ½

The dashed line is perpendicular, so its gradient is the negative reciprocal of 1/2 , -2.

Now, use $y - y_1 = m(x - x_1)$

$y - 2 = -2(x - 4)$

$y = -2x + 10$

$y = 10 - 2x$

Question 80: D

If one side of the square has length x then the radius of the circle is ½ x. The equation for the semi-circle is therefore $\frac{1}{2}\pi\left(\frac{1}{2}x\right)^2$.

$$x^2 - \frac{1}{2}\pi\left(\frac{1}{2}x\right)^2 = x^2\left(1 - \frac{1}{8}\pi\right) = 100 \rightarrow x^2 = \frac{100}{1 - \frac{\pi}{8}}$$

$$x = 10\sqrt{\frac{1}{1 - \frac{\pi}{8}}} = 20\sqrt{\frac{2}{8 - \pi}}$$

END OF PAPER

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2012: SECTION 1

Question 1: C

There is evidence for **A** in the passage, but also contradictions to it, so it is not the conclusion. The idea of **B** isn't mentioned at all in the passage. There is evidence for and against **D,** so it doesn't sum up all the passage well. **E** doesn't cover all the content in the passage, just part of it. This leaves **C,** which gives a good overview of the passage, making it the best conclusion.

Question 2: A

If the smoke alarms don't prevent fires, then installing them will not lead to less fires and by extension less death. Therefore, assuming that smoke alarms prevent fires is a flaw in the argument and so the answer is **A**.

Question 3: B

A isn't the best conclusion as nowhere in the passage does it suggest nicotine should be banned. It doesn't say that chewing nicotine gum cures addiction, so **C** is wrong. **D**, whilst not stated to be untrue, requires a leap in logic so isn't a good conclusion for the passage. Tobacco companies and money aren't mentioned at all so **E** is irrelevant. **B** summarises all points made in the passage well.

Question 4: C

If there was any drawback to portraying school life poorly then there would be a problem that needs to be addressed, but if there isn't a drawback then it doesn't matter if the shows aren't realistic.

Question 5: A

If the volume expands by 9% then the volume of the ice will be 109% of the original volume of the water. To get the original volume, we then just do $40 \div 1.09 = 36.7\ cm^3$.

Question 6: D

If all Crannies are Dervies then by reversing the argument, some of the Dervies are Crannies, that is if there are any Crannies. If there are Crannies, then some of these are Bongels, but all the Crannies are Dervies, so if Crannies exist then some Dervies are Bongels. If there are no Crannies there is no condition that some Dervies can't be Bongels, so **D** is not true.

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Question 7: E

Alice will take the 17:04 bus home from work, meaning she gets home at 17:33. She will then take 45 minutes to get ready, meaning the next bus she takes will be the 18:33 bus from her home. She will then arrive at the cinema at 18:58, but will take 10 minutes to buy her ticket, so will be ready to watch a film at 19:08. The next film after this time is the 19:15 showing.

Question 8: E

The passage makes a real point of placing the blame on us, the reader (human beings) for our use of technology, not modern technology itself, so **A** and **D** miss this point. Whilst **B** is mentioned, it is only mentioned as an example to back up the argument, not the entire argument itself, so it isn't the best conclusion, and this is the same situation with **C**. This makes **E** the best conclusion of the choices given.

Question 9: C

Whilst most of the passage emphasises the use of shower gel instead of soap as bad, the argument is rooted in the negative impacts of shower gel use on the environment, so any conclusion ignoring the environmental aspect is not correct. This rules out **B**. The last sentence also advocates for awareness, so the passage isn't just informative, but is encouraging change and activism. It then follows that **C** is the best conclusion.

Question 10: E

It doesn't say anywhere that cycling is more popular than all other modes of transport, so **A** is wrong. **B** and **D** are listed as possible causes, so aren't based on fact, but theories that can't be drawn from the passage. **C** isn't mentioned in the passage. Only **E** is alluded to in its entirety in the passage.

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Question 11: E

First, calculate the surface are that must be painted.

There will be 2 pairs of identical walls: one pair will be 3 × 4 and the other pair will be 3 × 9.

The spaces that don't need to be painted consist of two 2 × 1 spaces and a 3 × 4 space.

Therefore, the total area to be painted is $2(3 \times 4 + 9 \times 3) - (2 \times 2 \times 1 + 3 \times 4) = 62\ m^2$.

To find the amount of paint required just divide this number by 3 to get 62 ÷ 3 = 20.6666 ...which rounds up to 21, so 21 litres are needed.

Question 12: D

The easiest way of approaching this question is to imagine a population of men and work out the number of men with a high or normal PSA, and with and without cancer. Start with 1400 men, as it makes the sums easiest. Create the following table:

	Has prostate cancer	Does not have cancer	Total
High PSA			
Normal PSA			
Total			

If 1 in 14 men have cancer, then 1400 / 14 = 100 men have cancer and 1300 do not. 7% of these men do not have a high level of PSA, so 7 men have a normal level and 93 men have a high level. Add this information to the table:

	Has prostate cancer	Does not have cancer	Total
High PSA	93		
Normal PSA	7		
Total	100	1300	1400

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If 75% of men with a high level of PSA do not have cancer, then 93 men represents 25% of men in total with a high PSA. This means the number of men with a high PSA level, but no cancer, is 93 / 0.25 = 372. If there are 1300 men without cancer, and 372 with a high PSA level, then 1300 – 372 = 928 men have no cancer and a normal level of PSA. Add this to the table, so we have all the necessary information.

	Has prostate cancer	Does not have cancer	Total
High PSA	93	372	465
Normal PSA	7	928	935
Total	100	1300	1400

Finally, to calculate the probability of a man with a normal level of PSA having prostate cancer, divide the number of men with a normal PSA and cancer by the total number of men with a normal PSA level: $\frac{7}{935} \times 100 = 0.74 = 0.7\%$

Question 13: D

The argument doesn't consider that the animal rights supporters could be protesting against something other than the overall number of deaths, the reason for their protests is never mentioned.

Question 14: A

The passage explains lack of fog is threatening the redwoods. However, if global warming isn't to blame for the decline in the amount of coastal fog then global warming isn't harming the trees in this way, so the answer is **A**.

Question 15: D

Only one example is given so this could very well be an anomaly. No statistics are given to back the argument up so we don't know how regular this is. If this is not regular, then there is no danger to the fish.

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Question 16: C

Let t be the time when the overall cost of the 2 bulbs, including initial price and electricity cost, is the same. Then t must satisfy.

$0.6 + \frac{100}{1000} \times 0.15 \times t = 3 + \frac{20}{1000} \times 0.15 \times t$

$0.6 + 0.015t = 3 + 0.003t$

$0.012t = 2.4$

$t = 200$

Question 17: B

Let J be the number of DVDs Jane has at the start and D be the number of DVDs Duncan has at the start.

$J = 5D$ and $J + 12 = 2(D + 12)$

Solving these 2 simultaneous equations gives $D = 4$ and $J = 20$. Jane therefore has 32 DVDs now.

Question 18: A

Amount of Bolandian dollars bought by exchanging €300 a month is given by:

$300 \times (2.74 + 2.79 + 2.76 + 2.83 + 2.81) = 4179$

Amount of Bolandian dollars bought if exchanged all in May given by:

$300 \times 2.81 = 4215$

The difference is therefore 36 Bolandian dollars.

Question 19: D

A, **B** and **C** don't affect the argument at all, whereas **E** weakens it as the argument suggests rating figures being difficult to calculate is a new issue, whereas **E** suggests it has always been like this. **D** reinforces the sharing of music point so would strengthen the argument.

Question 20: E

The passage states that Medicine, Engineering and Computing should receive a lot of funding because of their benefit to society. It then states that Classics, Literature and Art should receive less funding, justifying it by saying "people who contribute the most" should be prioritised. This suggests the author believes that Classics, Literature and Art are not of use to society, and as such the author builds their argument on this assumption.

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Question 21: B

The idea that knowing other languages is useful is shown in the passage by giving examples where knowing other languages was helpful in other fields. Therefore, **B** is the answer. Whilst **A**, **C** and **D** are alluded to, they require a certain level of assumption so can't be drawn as a conclusion. **E** has no evidence to support it in the passage.

Question 22: A

The sentence, "The child actors who avoid this are often the ones who were encouraged to keep up their schooling and explore other career options" supports **A** fully, whereas there is no such sentence to support the other statements, so **A** is the best conclusion. The other answers are only alluded to, not specifically backed up.

Question 23: D

A, **C** and **E** aren't relevant to the argument at hand. **B** is relevant but **D** has proof that the suggested measure to combat obesity works, so it better supports the argument.

Question 24: E

When Tom gives the extra €6, he must do so to the child who received the 2 in the 5:3:2 ratio. This child then has the same amount of money as the child who received the 3 in the ratio, meaning each value of 1 in the ratio is equivalent to €6. Thus, the overall money given is $6 \times (5 + 3 + 2 + 1) = €66$

Question 25: A

3 shows a decay curve so must be P, as only P decays. 2 increases in amount and then decreases, whereas 1 only increases. The amount of R can only increase, so that must be 1, meaning Q must be 2.

Question 26: A

Whilst **B**, **C**, **D** and **E** are all true, they are all points made in the passage, not the actual overarching point which is **A**. **B** and **C** are not conclusions – just facts stated in the passage. **D** and **E** are facts used to back up **A**.

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Question 27: D

The maximum percentage of water requires the minimum percentage of everything else. For the ingredients other than the beans, sugar and tomato puree, the weight they contribute is negligible so they can be ignored. The ingredients list is in order of descending weight, so there cannot be less sugar than tomato puree – the minimum amount of sugar is 4.5%. Therefore, the maximum percentage of water is: 100 - (51 + 4.5 + 4.5) = 40%

Question 28: A

In the last turn, Adam and Dave effectively took 8 each as they each gave 2 to Sue. Therefore, in Sue's last turn she must have taken 4, as she needed to have taken 8 but receives 4 from the other players.

Question 29: C

If 20 households have neither a dog or cat, then 80 have one or both of them. To find those who have both, we add the number of people who have cats and number of people who have dogs and then take away the number who have a dog or cat or both.

60 + 40 - 80 = 20.

To find the number of people who have only cats we then take 20 from 60 to get 40.

Question 30: B

To calculate the added rainwater per week as a percentage of the overall volume of the bucket, we simply find 25% of 28, which is 7. Therefore, each week the bucket fills up an extra 7%. This means that after 2 weeks there will be $28 + 2 \times 7 = 42\%$.

Question 31: B

Let C be the length of the Cubba, D be the length of the Dile, and B be the length of the Bongo. Therefore we have, $D < C$, $B < E$ and $E > C$.

From these equations we can see that the only statement which is definitely true is **B**, as $E > C > D$, therefore $E > D$.

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Question 32: A

As there is no candidate that scored less than half of Peter's score, the wrong piece of the pie chart must be the piece with a 24.3-degree angle. Peter has double the amount of Rachel's votes and 113.4 = 2 × 56.7. Take this along with the fact that Peter has 1.5 times the amount of votes Alison has, and 75.6 × 1.5 = 113.4, then you can tell that Peter, Rachel and Alison are correctly represented. Rachel should have the smallest piece of the pie, but she doesn't, meaning the 24.3-degree piece corresponds to the person who was misrepresented. The 90-degree piece must represent Harold, not Kevin, as Harold came in between Alison and Peter and Kevin came after Alison, meaning Kevin must be represented by the 24.3-degree piece and therefore his score was copied incorrectly.

Question 33: C

Let x be the length of the tunnel in km. Then 16 - x represents the length of the track ignoring the tunnel. The time taken in the tunnel in minutes is then given by, $\frac{x}{20 \div 60} = 3x$ and the time taken outside the tunnel in minutes is given by $\frac{16 - x}{60 \div 60} = 16 - x$. Thus, 16 - x + 3x = 19, which gives x = 1.5

Question 34: C

E and **B** weaken the argument, they don't strengthen it. **A** and **D** are anecdotal so don't really affect the strength of the argument. This leaves **C** as the only answer that supports the argument given.

Question 35: E

The only loan that must be paid back either before or on the 4th Friday is the loan given on the first Friday. The student receiving back the least amount of loans leaves him with the least amount of money. This means on the fourth Friday the least amount of money he could have is 120 - 25 - 18 - 20 = €57.

Question 36: B

If driving in well-lit areas leads to a lack of concentration, then there are likely to be more accidents, as accidents are more likely when drivers are concentrating less. **A** and **E** aren't relevant to the argument and **C** and **D** would weaken the argument.

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Question 37: D

This just requires you to pick one of the values of one of the groups of the nutritional information per 100g, double it and divide this value by the value of the same group per biscuit. E.g. for salt:

$$\frac{0.52 \times 2}{0.08} = 13$$

Question 38: A

Even if the owner's motives are finically driven, this does not mean that eating grey squirrels won't protect red squirrels, or that grey squirrel meat isn't free range and low in fat and air miles. If the reasons for eating grey squirrel meat are still valid, then the counter argument is weak.

Question 39: B

B is stated in the opening sentence and is backed up throughout the passage, making it the main purpose of the argument and thus the obvious answer. **A** and **E** are actually wrong according to the passage. **C**, whilst potentially true, isn't stated in the passage and **D** is a fact given, not the purpose of the passage.

Question 40: A

Building 8 is 7 houses away from number 1, so building 11 is 7 houses away from the house with the largest number (the end house), as building 1 is opposite the building with the largest number and building 11 is opposite building 8. 11 + 7 = 18. Therefore, there are 18 houses.

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SECTION 2

Question 41: E

Glycosidic bonds take replace hydroxyl groups so i or iv will never be involved, ruling out **A**, **C** and **D**. There can be 2 arrangements: 1,6 or 1,4, which rules out **B**, but **E** satisfies all the conditions, so it is **E**.

Question 42: E

Synapses are gaps in between nerves. Here, the three neurons will be a sensory neuron, a motor neuron and a relay neuron within the CNS. Therefore, the synapses that connect to the relay neuron are in the CNS, so the answer is 2.

Question 43: A

Amino acids contain carbon, hydrogen, oxygen, nitrogen and some contain sulphur – 5 elements.
Polysaccharide carbohydrates, monosaccharide carbohydrates and lipids contain carbon, hydrogen and oxygen – 3 elements.
Water contains hydrogen and oxygen – 2 elements.

Question 44: B

Temperature and osmoregulation both involve the brain. However, blood sugar regulation is done by the pancreas, not the brain. The pancreas releases glucagon or insulin in response to a change in blood glucose concentration. The answer is **B**.

Question 45: A

P is a phospholipid which has 2 parts, the hydrophobic tail and the hydrophilic head. Q is an integral protein which also has a hydrophobic and hydrophilic part. Thus the answer is **A**.

Question 46: B

The pulmonary vein has the lowest CO_2 concentration as it transports oxygenated blood form the lungs to the heart. The renal vein has the lowest urea concentration as it transports blood from the kidneys (where most of the urea will have been removed) to the heart. These reasons make row **2** the correct row and thus **B** is the answer.

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Question 47: A
One key way to regulate gene expression is with transcription factors. These can bind to DNA to facilitate or prevent transcription and therefore these factors control the expression of certain genes, so the answer is **A**.

Question 48: A
The phenotype ratio of 9:3:3:1 is a result of a dihybrid cross from 2 heterozygous parents concerning 2 genes with 2 alleles. In this result some of the phenotypes will be the same as the parents and some will not be. This makes all the statements true and thus the answer is **A**.

Question 49: A
If they aren't identical then their traits will be different; traits come from alleles so the alleles must be different. This is because non-identical twins express different phenotypes and therefore they carry different versions of the same genes, so the answer is **A**.

Question 50: D
During metaphase, spindle fibres attach to the centromeres of the chromosomes, not the centrioles. These spindles then contract to pull the chromosomes apart during anaphase, so the answer is **D**.

Question 51: A
Hormones are part of the endocrine system. What distinguishes endocrine from exocrine substances is that endocrine hormones are released directly into the bloodstream, whereas exocrine substances travel through ducts – like pancreatic enzymes through the pancreatic ducts or bile through the bile ducts. This means **A** is false, as hormones are released from glands directly into the bloodstream.

Question 52: D
Diffusion and facilitated diffusion involve the movement of molecules down a concentration gradient and therefore do not require ATP for energy. Only active transport requires energy, so **D** is the correct answer.

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Question 53: C
A nucleotide consists of a nitrogenous base (the rectangle), a five-carbon sugar (the pentagon), and at least one phosphate group (the circle). Only v and iii contains them all, but there can only be one nitrogenous base and five-carbon sugar so it can't be iii, making the answer **C**.

Question 54: D
In **D**, you are guaranteed to get a G and N allele from one parent and a g and n allele from the other. This means the only genetic combination of the offspring is GgNn.

Question 55: B
A is irrelevant as people cannot become immune to antibiotics – people become immune to disease. **C** makes it easier to treat disease and does not cause existing antibiotics to be less effective. **D** is wrong as people do not become resistant to antibiotics; the bacteria do. **E** is also wrong as humans would not want to artificially select resistant bacteria! However, **B** is correct as people not finishing the full course of antibiotics is a cause of antibiotic resistance in bacteria, which makes antibiotics less effective.

Question 56: B
The ribosomes are where protein is synthesised and the RER is used to transport the protein into the vesicle, which leads to the Golgi apparatus where a carbohydrate may be added to make it a glycoprotein. Hence the order is 2→3→1.

Question 57: D
Adrenaline has no effect on the impulse rate of a sensory neuron. **1** and **2** are both increased as a result of the release of adrenaline.

Question 58: C
Hydrogen bonds are weak making **1** true and **2** false and ruling out **B** and **D**. Hydrogen bonds do not require hydrolysis to break, making **4** false and ruling out **E**. Hydrogen bonds are temporary, meaning **3** is true, so **C** is the correct answer.

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SECTION 3

Question 59: D

The general formula for an aldehyde is $C_nH_{2n}O$, which **D** clearly doesn't satisfy as it has too many carbons. **A** and **B** don't satisfy this either as they have more oxygens in them, but this could be due to a hydroxyl group which doesn't make it not an aldehyde, hence **D** is the answer.

Question 60: E

1 is false as AgCl is insoluble (the bonds between AgCl are too strong and there isn't a large enough increase in entropy afterwards). **2** is false as sugar dissolves in water, in fact any polar covalent molecule will usually dissolve in water. However, **3** is true so the answer is **E**.

Question 61: D

Oxidising agents get reduced so their oxidation numbers decrease. In the first reaction, O_2's oxidation number decreases from 0 to -1, so it is an oxidising agent. In the second reaction, Fe^{3+}'s oxidation number decreases from +3 to +2, so it is an oxidising agent. In the third reaction, H^+'s oxidation number decreases from +1 to 0, so it is an oxidising agent. Hence, the answer is D.

Question 62: C

Iron, copper and zinc are all transition metals. While iron and zinc are not particularly reactive, copper is very unreactive. Therefore, they all take part in displacement reactions, when their compounds react with more reactive metals.

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Question 63: E

The chemical formula for cyclohexane is C_6H_{12}, which can be worked out by using the general formula for cyclic carbons, C_nH_{2n}, with n = 6.

Cyclohexane then will have an A_r of $6 \times 12 + 12 \times 1 = 84$.

The number of moles in 0.420g is given by $0.420 \div 84 = 0.005$.

The number of cyclohexane molecules is then given by $0.005 \times 6.0 \times 10^{23} = 3 \times 10^{21}$ as the Avogadro constant tells you how many molecules in a mole of something there is.

The number of hydrogen atoms is then 12 times the number of cyclohexane molecules, as there are 12 hydrogens in a cyclohexane molecule.

$3 \times 10^{21} \times 12 = 3.6 \times 10^{22}$.

Question 64: D

Sodium chloride has an ionic bond. The chlorine gains an electron whilst the sodium loses one when forming sodium chloride. Hence the chlorine ion has 18 electrons and the sodium ion has 10.

Question 65: A

Oxygen doesn't have a full outer shell, so adding an electron to it (the first electron affinity) makes it more stable, so it releases energy and is exothermic. However, when adding a second (the second electron affinity) there is repulsion between the two negative species, which requires a lot of energy to overcome, much more so than what is released once the electron is there, so this reaction is endothermic.

Question 66: E

Although all the bonds seem to be ionic, the electronegativities of beryllium and iodine are similar enough such that the bond may be considered to be covalent. The similarity in the electronegativity of iodine and beryllium compared to the other elements shown is because electronegativity increases across a period and decreases down a group.

Question 67: E

Reaction 1 is a displacement and substitution reaction. Reaction 2 is a precipitation reaction. Reaction 3 is an oxidation/reduction reaction. Hence, only elimination is not shown.

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Question 68: E

Ethanoic acid is a weak base, so will react with a strong base in an amine but not a weak one in an amide. Nitric acid is a strong acid, so will react with both an amine and an amide. This means both the first 2 rows are correct. Sulfuric acid is a strong acid, so will react with an amine and it will cause hydrolysis to take place, this makes the first part of the third row wrong. So, the answer is **E**.

Question 69: B

Li has a valency of 1 and therefore only forms +1 ions. **B** cannot be true as it would be a +2 ion in this compound since CO_3 has a valency of 2. The answer is therefore **B**.

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SECTION 4

Question 70: C

If $x^2 < 9$ then $-3 < x < 3$.

If $2x + 3 \geq 5$ then $x \geq 1$.

Therefore, the range of values that satisfy both equations is $1 \leq x < 3$.

Question 71: C

The equation required will be $q = mc\Delta t$. Equate 2 of these equations to each other: one for the energy the iron loses and the other the energy the water gains, eliminating the need to find q. Therefore, the mass of the iron and water will be needed. The change in temperature will be needed (taken from start and end values) and the specific heat capacity of water will be needed. Nowhere will the thermal conductivity of the iron be needed.

Question 72: E

The entropy of the paraffin will increase so **1** is correct. The energy added in the form of heat will be used to break the intermolecular bonds, not raise the temperature, so 2 is correct. However, carbon hydrogen bonds will not be broken, so **3** is incorrect making E the answer.

Question 73: D

If there is no resistance, then no thermal energy will be released, so no thermal effect. There is no chemical effect with mercury as a conductor anyway, as it is one element. However, where there is electricity and metals, there is magnetism, so the answer is **D**.

Question 74: D

In parallel the total capacitance of capacitors is just added, however in series the total capacitance is given by the addition of their reciprocals inverted. Therefore, a larger overall capacitance for the same number of identical capacitors, would be given by more capacitors in parallel. 1 has the least capacitors in parallel then 2 then 3, hence this is also the order of their total overall capacitance.

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Question 75: C

A vector has a magnitude and a direction. For example, velocity has a value but also a direction. Electric charge is just a value with no direction, so it is not classified as a vector. Therefore, the answer is **C**.

Question 76: C

Using log laws:

$\ln(x^2y) - 2\ln(xy) + 3\ln(y)$

$= \ln(x^2y) - \ln(x^2y^2) + \ln(y^3)$

$= \ln\left(\frac{x^2y \times y^3}{x^2y^2}\right)$

$= \ln(y^2) = 2\ln(y)$

Question 77: B

If none of the males study maths, then p = 0 – this is its lowest value. If as many of the males that can study maths do, then we have the highest value for p. That probability of picking a male who studies maths is a third, as $\frac{2}{5} > \frac{1}{3}$. If m is the probability of choosing a male and M is the probability of choosing a student who does maths, then

$P(m) = \frac{2}{5}$, $P(M) = \frac{1}{3}$ and $P(M \cap m) = \frac{1}{3}$

From probability laws

$p = P(M \mid m) = \frac{1}{3} \div \frac{2}{5} = \frac{5}{6}$

Question 78: A

After undergoing R twice we are at A, S then leaves us still at A, undergoing R again puts us at B but then after S again we are no longer on the pentagon and R will not put us back on it, so **A** will not leave D at its start position.

Question 79: E

The best way to do this would be to draw a quick graph. Then, it can be seen quite easily that (1, -1), (1, 3), (4, 9) and (6, 9) are all 1 point away from the line on the x axis and 2 points away on the y axis. However, (5, 13) is 2 points away on the x axis and 4 points away on the y axis, so E is the correct answer.

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Question 80: B

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$F = 75 \times 10 = 750$

$A = 1 \times 10^{-6} \times 10000 = 0.01$

$$F = \frac{750}{0.01} = 7.5 \times 10^{4}\ \text{Pa}$$

END OF PAPER

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2013: SECTION 1

Question 1: A

The passage passes no judgement on the issue and just states the facts, so a conclusion to this passage must reflect this. **C**, **D** and **E** do not so they are not a good conclusion. Nowhere in the passage does it say that elderly people expect the state to care for them, so **B** is wrong, making **A** correct.

Question 2: E

Companies would only be reluctant to release information it is able to be copied freely, but the patent laws prevent plagiarism from happening, so there is no drawback for the companies releasing this information.

Question 3: C

The passage describes how certain buildings are in danger of being ruined if laws do not change to help preserve them. **A** and **E** are not stated anywhere in the passage whilst **B** and **D** are facts used to back up the overarching argument of the passage, which is **C**.

Question 4: C

The point of the passage is to compare gap years abroad and in our own country. Any conclusion that ignores this is not a good conclusion, making **C** the best conclusion as the others lack comparisons. A isn't stated at all in the passage and B and E are used as reasons, not as the point itself. **D** is an opinion not backed up by the passage at all.

Question 5: E

The passage states how a special aptitude for learning may result in increased motivation. **E** isn't a flaw, as it is the actual conclusion of the passage, with discussion based off of research to back it up.

Question 6: B

The Inca civilisation began in the highlands of Peru in the early 13th century. It ruled for over 100 years before the Spanish conquered the stronghold in 1572. Therefore, the answer is **B**.

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Question 7: D
Placebos are drugs designed to test whether the patient is improving due to the drug being tested or just believing that they are being treated – to do this they must be inactive.

Question 8: C
The argument only takes into account those living in heavy traffic areas. Not everyone lives in a high traffic area and these people are not represented so they may not want to use public transport even if it was improved. Therefore C is a flaw in the argument.

Question 9: B
Hannibal crossed the Alps with his army in 218 BC. This was a significant moment in the Second Punic War and is regarded as being one of the most celebrated achievements in ancient warfare.

Question 10: E
The World Health Organisation was founded in Geneva in 1948 after the Second World War. The organisation is a member of the United Nations Development Group and it regulates healthcare across the globe.

Question 11: E
The top 7 levels have in total:
$7 \times (2 \times 15 + 6 \times 10) = 630$
And the bottom level has:
$2 \times 15 + 4 \times 10 = 70$
Giving 700 spaces in total.
To work out the maximum number of members of the public admitted, we must work out 90% of this and take 4 giving:
$(700 \times 0.9) - 4 = 626$.

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Question 12: C

The price per kg for the regular jar is:

$\frac{4.5}{250 \div 1000} = 18$

And for the large jar it is:

$\frac{6.3}{400 \div 1000} = 15.75$

Giving a difference of €2.25.

Question 13: E

3.51 pm would appear as 15.51, which appears the same upside down in the way the numbers are written. This is due to the numbers having a centre of inversion. Therefore, the answer is E.

Question 14: B

If a candidate got over 50%, then the candidate who got 350 votes came second. If no candidate got over 50%, then the candidate who got 350 votes was definitely in the top 2 as there aren't enough votes remaining for 2 candidates to beat him. Therefore, the candidate goes to the second ballot and either came second or first.

Question 15: D

The longest unbroken world record started at 1904 with a time of 21.6 seconds and ended at 1932 with a time of 21.2 seconds. Therefore, the record was unbroken for 28 years, so the answer is D.

Question 16: C

This passage is about how deviations are used to decide if Planet X exists; any conclusion not referencing these deviations, such as **A**, **B** and **D**, is not the conclusion. **E** is a reason as to why **C** is the case, making **C** the main point and thus the best conclusion of the passage.

Question 17: D

It makes no logical sense that having a different name makes you more likely to go to university. The fact that there is a correlation doesn't mean that this is the reason why, just that this is a trend.

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Question 18: B
Nowhere in the passage does it state **A** and **E**. **C** is a fact portrayed in the passage, whilst **D** is a reason for the main point of the argument, which is **B**. **B** states that students must be helped to appreciate the importance of literacy skills, which is the conclusion of the passage.

Question 19: C
The bag contains 24 whole scoops. Therefore, it must contain:
$24 \div \frac{3}{4} = 32$ three-quarter scoops.

Question 20: A
If there was more teaching in a 2-year course then the same amount of content could be covered in 2 years as 3, making 2 years sufficient to cover all the required content for engineering.

Question 21: D
A, **B**, **C** and **E** are not even suggested in the passage, whereas **D** is backed up in the passage, especially by the last sentence.

Question 22: C
Using a bit of logic we can decipher that the discovery of electricity and thus batteries was a long time after the other discoveries, making it the odd one out. Galileo therefore did not design an electric battery.

Question 23: A
The new price of the pasta will be €1.40 and 10% off this new price will be:
$1.40 \times 0.9 = 1.26$
Therefore, the answer is **A**.

Question 24: B
The passage only mentions that some aspect of your happiness and person is due to factors out of your control making **C**, **D** and **E** false. **B** is better supported than **A** as the passage recognises the idea of the soul being used, which **B** encompasses and **A** does not.

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Question 25: B

The Beta air flight is 30 minutes quicker than the Alpha air flight and as the Alpha air flight takes place every 10 minutes, a Beta air flight will overtake 30 ÷ 10 = 3 planes due to them setting off at different times.

Question 26: A

The amount of the walk left as a percentage of the overall walk after the next 4 days can be worked out by doing:

100 - 60 - 40 × 60 = 16

(The last bit of the sum is what 60% of the remaining 40% of the walk is in terms of a percentage of the overall walk).

This means that 16% equates to 60 miles, so to calculate the overall length of the walk we do:

60 ÷ 0.16 = 375 miles.

Question 27: E

The internal dimensions of the base of the safe have nothing to do with the height of the safe. The width and depth of the inside of the safe are constant throughout the safe, and so is the same as the base and are the values stated minus 8 cm, which is from the 2 walls either side. This makes the width of the inside of the base at 40 cm and the depth at 36 cm.

Question 28: C

We can see that the big face has rotated clockwise around over 8, but under 9 sections, making the time something past 8. The little face has rotated around 8 sections anti-clockwise, meaning 40 minutes has passed after 8, making it 8.40.

Question 29: D

Unemployment has fallen in the USA, UK and Germany, but out of these 3 countries inflation has only increased in the USA. Therefore, the statement is only referring to the USA and the answer is **D**.

Question 30: B

If the great nations of the world didn't have helicopters which could have reached Haiti in a week, then in that timeframe they could not have done anything, so have no reason to feel ashamed.

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SECTION 2

Question 31: C

During transcription, mRNA is produced. This is then carried to the ribosomes, where translation occurs to form a peptide chain, which is how proteins are produced from a genetic code.

Question 32: C

The pulmonary vein and artery enter and leave the heart, respectively, above the diaphragm. The whole heart is also situated above the diaphragm, as are the alveoli of the lungs. The liver sits below the diaphragm on the right-hand side.

Question 33: B

Amino acids are present in peptides. Viruses contain peptides. Enzymes and antibodies are polypeptides, made up of amino acids. Cell membranes contain peptides as signalling molecules. However, amylose is a carbohydrate that does not contain any amino acids.

Question 34: E

Ribosomes are present on the rough endoplasmic reticulum. They receive mRNA from the nucleus and produce a polypeptide chain during translation. They are not involved in transcription.

Question 35: C

Water is required to break down a phospholipid into smaller components. Therefore, no water is released during this process or once they have been broken down, so the answer is 0.

Question 36: E

1 is true as it would be opposite the second triplet in the shown base sequence. As each triplet contains one of either A or T and two of either C or G, there will indeed be 8 hydrogen bonds in each triplet, so **2** is true. However, there would only be one uracil base as there is only 1 A in the sequence, which is what uracil pairs to, so **3** is false.

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Question 37: A
If the condition was sex linked and dominant, then it would have to be caused by a mutated X chromosome as the X is dominant. However, this is not possible as then one of the parents must also be affected by the condition, which is not the case.

Question 38: C
Beta cells are present in the pancreas and release insulin in response to a high blood glucose concentration. This process has no effect on defending the body against infection, so the answer is **C**.

Question 39: A
Anaerobic respiration produces only lactic acid and energy, Glycolysis produces 2 pyruvate molecules, 2 NADH molecules and energy. The Krebs cycle produces 3 NADH molecules, one QH_2 molecule and 2 CO_2 molecules. Therefore, **1** and **2** are false and **3** is true.

Question 40: B
If there is 32% guanine, then there must be 32% cytosine too. This leaves 36% to be split equally between thymine and adenine, meaning 18% of the DNA sample is thymine and the answer is **B**.

Question 41: A
Mitosis begins with prophase, then metaphase where the chromosome line up along the equator. Anaphase involves the separation of genetic information into two separate cells, which is immediately followed by telophase, so the answer is **A**. Remember the acronym PMAT for the order of the stages of mitosis.

Question 42: C
All of these factors increase the frequency of the phenotype. The factors are also linked: both **3** and **1** can lead to **2**.

Question 43: D
A, **B**, **D** and **E** are produced during photosynthesis. **D** and **C** are produced during respiration. Therefore, ATP is produced during both photosynthesis and respiration, so the answer is **D**.

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Question 44: A

During metaphase, a cell does not have a nucleus or ribosomes that are clearly visible. Therefore, to identify a cell as being eukaryotic during metaphase, mitochondria can be used.

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SECTION 3

Question 45: B

The direct transition of a substance from gas to solid or vice versa (such as that of carbon dioxide) is referred to as sublimation. Therefore, **B** is not correct since it states that this process is called freezing.

Question 46: C

The first reaction is the addition of HBr over a double carbon bond. The second reaction is substituting Br with a nitrile. The last reaction is the reduction of nitrogen with hydrogen.

Question 47: E

An isomer has the same molecular formula, but a different structural formula making **1** and **3** correct. However, as they may have different functional groups their properties can be very different, making **2** false.

Question 48: C

Each bond represents 2 electrons, so a triple bond has 6 electrons making **3** correct. **2** is also correct since the electrons in the double bond repel each other slightly, as do the 2 nuclei. **1** is correct as due to the higher electrostatic attraction forces from the carbon nucleus to the bonding electrons, the nuclei come in closer making the bond shorter.

Question 49: A

Ga cannot form a 2+ ion so can't bond to a carbonate ion in a one-to-one ratio. This is because a carbonate ion has a valency of 2 and therefore 2 Ga atoms would have to bond to 3 carbonate molecules.

Question 50: E

In NOCl and KNO_2, nitrogen has an oxidation number of 3. In NO_2, nitrogen has an oxidation number of 4. In NO_2Cl and $Ca(NO_3)_2$, the nitrogen atom has an oxidation number of 5, so the answer is **E**.

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Question 51: B

From the number of potassium atoms on each side we get that $4 = 2\mathbf{b}$, therefore $\mathbf{b} = 2$.

From the number of sulphur atoms we get that $\mathbf{a} = \mathbf{b} + 4$, therefore $\mathbf{a} = 6$.

From the number of hydrogen atoms, we get that $2\mathbf{a} + 5 \times 6 = 5 \times 4 + 2\mathbf{c}$

Therefore, $12 + 30 = 20 + 2\mathbf{c}$, so $\mathbf{c} = 11$.

Question 52: A

The molecular formula for ethane is C_2H_6, so the Ar for ethane is 30. Hence the number of moles of ethane in 3.0kg is given by:

$$\frac{3 \times 10^3}{30} = 100$$

This means that there are $100 \times 6.0 \times 10^{23} = 6.0 \times 10^{25}$ molecules of ethane.

There are 6 hydrogens in ethane, therefore there are $6 \times 6.0 \times 10^{25} = 3.6 \times 10^{26}$ hydrogen atoms.

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SECTION 4

Question 53: A

In simple harmonic motion, the kinetic energy is at a maximum in the equilibrium position and potential energy is at a maximum at the extremes. In this case, the equilibrium position is halfway up, and the extremes are at the top and bottom of the mass's motion. This means that **1**, **2** and **3** are all correct.

Question 54: A

Let x be the distance of the 80N weight from the other end. Using the fact that moments about the string anticlockwise equals moments about the string clockwise, we have that:

$0.5 \times 300 = 0.5 \times 100 + 80 \times (2 - x)$

Which simplifies to: $100 = 80(2 - x)$

Which leads to: $\frac{5}{4} = 2 - x$

Thus $0.75 = x$

Question 55: E

Using more turns would increase the voltage produced. If the speed increased this would also increase the voltage produced and vice versa. However, the thickness of the wire makes no difference to the voltage produced, so **1** and **3** are true whereas **2** is false.

Question 56: D

The equation describing a circle like this is given by:

$(x + 1.5)^2 + (y - 0.5)^2 = 3^2$

This simplifies to:

$x^2 + 3x + 2.25 + y^2 - y + 0.25 = 9$

If take the 9 to the other side and multiply by 2 you then get:

$2x^2 + 6x + 2y^2 - 2y - 13 = 0$

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Question 57: E

We know that:

$$P = \frac{V^2}{R}$$

And that mgh and $\frac{1}{2}mv^2$ have units of energy, so if you divide them by time you will get units of power.

Question 58: D

Using log laws we get that:

$$\ln\left(\frac{x^2}{4y}\right) + \ln(xy) + \ln(8)$$

$$= \ln\left(\frac{x^2 \times xy \times 8}{4y}\right)$$

$$= \ln\left(2x^3\right)$$

$$= \ln\left(x^3\right) + \ln(2)$$

$$= 3\ln(x) + \ln(2)$$

Question 59: C

If $12 - x^2 > 8$, then $4 > x^2$ and therefore $-2 < x < 2$.

If $2x + 3 \geq 5$, then $x \geq 1$.

The range of values that satisfy both conditions then are $1 \leq x < 2$

Question 60: A

The horizontal and vertical sides of the triangle (call them x) can be worked out by drawing a radius from the centre of the circle to the edge of the circle where it touches the triangle. The angles in the triangle will then be 90, 45 and 45 degrees.

Then using the sine rule:

$$\frac{r}{\sin(45)} = \frac{x}{\sin(90)}$$

Which gives that $\sqrt{2}r = x$. Thus the area of the unshaded region is given by

$$\frac{1}{2}(\sqrt{2}r)^2 - \frac{1}{4}\pi r^2 = \left(1 - \frac{1}{4}\pi\right)r^2$$

END OF PAPER

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2014: SECTION 1

Question 1: D

The passage states the destroying the smallpox virus may be an error seeing as we do not know what use it may be in the future, and also since we have no right to deliberately destroy a species. Therefore, before it is destroyed, it would be worth thinking further about how it could be used in the future, so **D** is correct.

Question 2: D

The passage describes how while in an ideal world the Olympic games would not be political, countries make the Games political to benefit themselves or to make a political point. Therefore, it is a myth that the Olympic Games are not political, which is exploited by these countries that host the games for their own benefit, so the answer is **D**.

Question 3: C

The passage states how the purpose of an election is for the people to vote for who they want to be elected and not whom they want to not be elected. Therefore, tactical voting is not in line with the main purpose of elections and so **C** is correct.

Question 4: E

The main assumption drawn from this argument is very clear. It suggests that saying this phrase will help you to abide by the two second rule, thereby assuming that this phrase takes no less than two seconds to say, so the answer is **E**.

Question 5: A

In the tetrahedron, the square will be next to the circle and that will be between the triangle and the square. The square is the wrong orientation in **D** and **E**. The triangle is the wrong orientation in **C**. The shapes are in the wrong order for **B**, so **A** is correct.

Question 6: B

The passage describes how being a top footballer increases life expectancy purely as a result of success and does not explore any other reasons for why this may be the case. **B** is therefore correct.

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Question 7: E

For each race, Philip either won 11, 8 or 6 points. Philip must have finished with at least 8 points in the majority of his races to get to the total of 61. To finish on an odd number, he must have won either 1, 3, 5 or 7 races. However, even if he had won 3, 5 or 7 races, the minimum points that he could have received was still 63. Therefore, he must have only won one race and the answer is **E**.

Question 8: B

The passage explains how combining traditional music with more contemporary forms could well be beneficial as it attracts a wider audience. Therefore, contemporary music has a place in opera performances and **B** is correct.

Question 9: C

The cost of making the necklace will be €1.50 + €2.70 = €4.20. 70% of this is €2.94, which when added to the original cost of making, results in a final price of €7.14. The answer is **C**.

Question 10: B

While introducing this policy in the amateur leagues is a good idea, it is not clear just how it will be implemented right up to a professional standard. This passage would be weakened if for example, there was no easy way of the policy reaching the professional game, such as if professional footballers do not originate from the amateur game. Therefore, **B** is correct.

Question 11: C

If on Friday Tessa made 205 bracelets, she will have earned 30 x $3 extra that day, meaning her basic wage + Friday's extra work will have paid her $410. The minimum number of bracelets she can make will result from her doing the extra work on only one or two more days. She therefore must have made 200 on one day, earning $75 extra, and therefore got $30 more on another day, thereby making 185 bracelets. This makes a total of 150 + 150 + 185 + 200 + 205 = 890 bracelets, so the answer is **C**.

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Question 12: C

Each of the competitors won once at least. However, Barry, Daniel and Eric came second each time, meaning they were the most likely to win the competition. Since Daniel and Eric could not score points at the same time, whenever one of them won, Barry would come second. They also could only win once, as the 1-2 finishing order could not be repeated. If one of them came second, the winner would either be Alan, Barry or Carl. Even if Alan and Carl won another two games each, Barry would win the other won and all his second-place finishes would make him the overall winner. The answer is therefore **C**.

Question 13: E

The passage describes the use of pictures to prevent people from smoking. Therefore, if these pictures were not displayed as widely as is suggested in the passage, then this would weaken the argument. An example of this is if there is a ban on advertising tobacco, so **E** is correct.

Question 14: A

All we need for this question is the last sentence. If 3/5 of the remaining distance was covered on day 9, then 2/5 was done on day 10, meaning 54km was travelled on day 9. Therefore, if day 9 and 10 was a quarter of the journey, and 90km was travelled in that time, the total distance was 360km and the answer is **A**.

Question 15: B

He will need 28 litres if he uses Non Drip Gloss, costing 16 x 11 + 8 = €184. 22 litres of the Satinwood will be needed, costing 20 x 9 = €180. 20 litres of the Quick Dry Gloss will be needed, costing €160. Finally, 16 litres of the Once Gloss will be needed costing 18 x 6 + 12 = €120. Therefore, the answer is **B**.

Question 16: C

The more jars purchased, the lower the average cost per jar will be. However, this will not be linear, as the biggest saving will be made after the third jar is bought (and the savings will get less with each consecutive jar bought). Therefore, by looking at the graphs we can see that the answer is **C**.

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Question 17: A

To get from 12 to 16, the board will only have room for 13 and 14 on the bottom row and then 15 on the middle row. To get from 18 to 26, there will need to be 3 more columns to the right of 18. This makes a total of 7 columns. The board will therefore be 7 x 7, making a total of 49 squares. The answer is **A**.

Question 18: C

The passage claims that carbon monoxide and nicotine are both responsible for increasing blood flow. A statement that would claim either of these was not involved in this process would be an assumption that is not in the argument. Therefore, **C** is correct.

Question 19: D

The passage describes how our effectiveness is affected by the use of our mobile phones and claims that these devices are only a hindrance. The flaw in the argument is that mobile phones increase our effectiveness since they can send and receive information instantly, therefore **D** is correct.

Question 20: A

Any diagram where there is a vertical line all the way up the midline does not take into account the cylindrical structure directly in front of the person's chair. Therefore, **A** is not possible.

Question 21: D

The easiest way to answer this question is to draw out each of the options **A**-**E** to see how the two shapes fit together. This is not possible for **D**, as the right-hand piece will have to be placed along the bottom right of the diagram, but this does not leave sufficient room for the left-hand piece to fit in.

Question 22: C

The passage explains how altered pre-frontal cortex activity in the brains of screen-obsessed teens may affect their ideas of consequence and empathy. In doing so, this may lead to a reduction in inhibiting violent actions in real life and therefore the passage suggests a link between computer games and violence, so the answer is **C**.

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Question 23: C

The passage starts by discussing the problems with publicising crimes, but then quickly moves on to state that the freedom of speech of the media is too important, therefore concluding that the media should be allowed to report crime regardless of whether other crimes are caused by this. The answer is **C**.

Question 24: D

William Harvey studied the body and was particularly interested in the blood. Therefore, he is famous for describing the circulation of blood. De Motu Cordis translates to 'the motion of the heart' from Latin so the answer is **D**.

Question 25: C

OPEC stands for the Organisation of the Petroleum Exporting Countries. This is an intergovernmental organisation to control the sale of oil between countries that was founded in 1960, so **C** is correct.

Question 26: A

Monet and Renoir were both impressionist artists. Impressionism was an art movement in the 19th century that was characterised by thin brush strokes, focusing particularly on the accurate depiction of light. The answer is therefore **A**.

Question 27: B

Mark Zuckerberg founded Facebook in 2004. This is an American online social media and networking service, which began at Harvard University and was initially used exclusively for University students but has now become a global network. The answer is therefore **B**.

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SECTION 2

Question 28: B

Blood glucose changes are detected in the body by specialised cells in the pancreas. These then act to release insulin or glucagon in order to counteract the change, therefore the answer is **B**.

Question 29: D

Sexual reproduction produces an organism that is not identical to the original organism whereas asexual reproduction produces clones of the original organism. However, some organisms are adapted to perform both sexual and asexual reproduction, therefore the answer is **D**.

Question 30: D

For a sex-linked recessive condition, the mutated allele is carried on the X chromosome, but two copies are needed for the phenotype to be expressed in woman, where as the man only needs one copy. Therefore, if a male is unaffected, they will not be a carrier for the mutated gene. Person 2 cannot be a carrier as they are unaffected, and the same goes for person 4. Person 3 may be a carrier for the condition. Person 5 is definitely a carrier, since their son has the condition, but their husband does not. Person 1 has to be a carrier, since the mutated allele must have come through her. This is because the affected person's father and grandfather do not have the mutated allele. The answer is therefore **D**.

Question 31: C

The complementary mRNA strand will have complementary bases to the DNA and the thymine molecules will be replaced with uracil. Therefore, the strand will look like GUG CAA CCG UAU CUG with the substitution mutation at the first base of the third codon, so the answer is **C**.

Question 32: B

The more double bonds in the phospholipids of the cell membrane, the more the fluidity is maintained. Therefore, in colder conditions there will be more C=C double bonds in the bilayer, so it's **B**.

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Question 33: E
HIV is a retrovirus, so its genome is made of RNA, which is copied into DNA by its reverse transcriptase. It has a membrane made up of phospholipids. Therefore, **E** is correct.

Question 34: C
Exocytosis of neurotransmitter from the presynaptic membrane ensures neurotransmitter only moves in one direction. The sodium-gated channels being present on the postsynaptic membrane ensure the action potential is only fired in one direction. Therefore, the answer is **D**.

Question 35: A
The RER sends proteins to the cell membrane or Golgi in vesicles. At the Golgi, modified proteins are then packed into vesicles again and the cell membrane can also be used to form vesicles. Therefore, the answer is **A**.

Question 36: A
The first fragment will join to the last fragment to make 150 + 50 = 200 bp. This is because the DNA is a plasmid and is therefore circular in shape. The second will be 100 bp. The third will be 700 bp so the answer is **A**.

Question 37: E
After meiosis, there will be double the number of chromosomes, as there will be 4 daughter chromosomes, two of which will be recombinant. None of these chromosomes will be genetically identical due to the recombination process, therefore the answer is **D**.

Question 38: C
When the semi-lunar valves close, the blood has left the ventricles and entered the greater vessels. Therefore, the pressure will be greater in these vessels compared to the ventricles. The answer is therefore **C**.

Question 39: B
1 is a ribosome that contains tRNA that facilitates translation. 2 is the RER where the protein that has been produced is present. This protein is made up of peptides and is therefore classified as a polypeptide, so the answer is **B**.

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Question 40: A

Bacteria are prokaryotes and most of them are susceptible to the antibiotic penicillin. RuBisCo is an enzyme needed for photosynthesis, so will be present in a plant cell. The answer is **A**.

Question 41: D

Increasing the concentration of the substrate will increase the rate of reaction until the enzymes become saturated, so the curve will look like P. If a competitive inhibitor is present, for the same concentration of substrate, the rate of reaction will be lower. However, the maximum rate of reaction will still be reached when the substrate concentration is high enough, so it will look like curve Q. Therefore, the answer is **D**.

Question 42: E

During glycolysis, pyruvate is produced. If there is insufficient oxygen, the pyruvate is respired anaerobically. In animals the pyruvate is turned into lactate and in yeast the pyruvate forms ethanol. Therefore, the answer is **E**.

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SECTION 3

Question 43: E

HCl is a strong acid, so we assume complete dissociation, where all of the acid is present in the form of protons and chloride ions. Therefore, there will be 0.1 M of H^+. If pH = - $\log_{10}$ [H^+], the resulting pH will be 1, so the answer is **E**.

Question 44: E

We need to calculate the stoichiometry for the reaction first: $Zn + Pb(NO_3)_2 \rightarrow Pb + Zn(NO_3)_2$

1.30/65 = 0.02 moles of zinc react.

We therefore expect 0.02 moles of lead to be produced.

3.31/207 = 0.016 moles of lead are produced, so the percentage yield is 0.016/0.02 = 80%, therefore the answer is **E**.

Question 45: B

During discharge, electrical energy is produced, resulting in a redox reaction. At the negative anode, the lead is oxidised from $Pb \rightarrow Pb^{2+}$, a change in oxidation number from $0 \rightarrow 2$. At the positive cathode, the PbO2 (where the Pb has an oxidation number of +4) reacts with protons and electrons to form lead and water. This is a change of oxidation number from $4 \rightarrow 2$. The answer is **B**.

Question 46: D

Oxidisation of ethane involves the loss of electrons from the double bond, which are then donated to electron acceptors like halogens. Therefore, CH_2BrCH_2Br is produced if ethane reacts with bromine, so **D** is correct.

Question 47: D

Doubling the concentration of a reactant will double the rate of reaction. Doubling the concentration of hydrogen peroxide, but using the same volume, will double the number of moles that react. Therefore, double the amount of oxygen will be produced so **D** is correct.

Question 48: B

If an atom has an electron configuration ending p^5, it will have a $1s^2$ orbital, a $2s^2$ orbital and a $2p^5$ orbital. Therefore, it will have 2 + 2 + 5 = 9 electrons in total. The answer is therefore **B**.

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Question 49: B

Calcium has a valency of 2; so 2 moles of hydrochloric acid will react with 1 mole of calcium carbonate. In 2g of calcium carbonate, there are 2/100 = 0.02 moles, so this will react with 0.04 moles of hydrochloric acid. If moles = volume x concentration, then volume = 0.04/2 = 0.02 L or 20 cm^3 and the answer is **B**.

Question 50: E

There are only 13 compounds, so **A** is immediately ruled out. Some metal oxides, such as Al_2O_3, are amphoteric. KOH, P_4O_{10}, MgO and Na_2O all form alkaline solutions in water and are therefore alkaline. The rest of the compounds are acidic. The answer is therefore **E**.

Question 51: C

Forming a carboxylic acid from an alcohol is oxidation. Adding an alcohol to a carboxylic acid forms an ester whereas adding ammonia will form an amide. The answer is therefore **C**.

Question 52: B

Halogen atoms are able to form very strong covalent bonds, meaning in a gaseous state they have the strongest permanent molecular dipole. Therefore, **B** is correct, since it contains molecules which have halogens involved in covalent bonds.

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SECTION 4

Question 53: D

The force pushing down on the book is 0.4 x 10 = 4 N. The force of friction is therefore 0.5 x 4 = 2 N. The total driving force of the book is therefore 10 – 2 = 8 N. If F = ma, a = 8/0.4 = 20 ms^{-2}. The answer is **D**.

Question 54: D

As the temperature falls, the density of the liquid increases. This allows the glass spheres to rise, since the density of the air inside has not changed as much. Therefore, **D** is correct.

Question 55: D

To find the gradient of a straight line, we must rearrange the perpendicular line equation so that it is in the form y = mx + c.

This gives us y = -3/4 x + 2, so the gradient of the perpendicular line will be 4/3.

c represents the point at which the line crosses the y-axis, where x = 0.

Working from (-6, 2) to the y-axis, the point where the line will intersect this axis will be at (0, 10), so c = 10.

Therefore, y = 4/3 x + 10 so:

3y – 4x = 30 and the answer is **D**.

Question 56: B

$\sqrt{(1.6 \times 10^7)} = \sqrt{(16 \times 10^6)} = 4 \times 10^3$

$(8 \times 10^{-5}) / (4 \times 10^3) = 2 \times 10^{-8}$

$(1.2 \times 10^3)^2 = 1.44 \times 10^6$.

$1.44 \times 10^6 \times 2 \times 10^{-8} = 2.88 \times 10^{-2}$ so the answer is **B**.

Question 57: C

The surface area of a sphere is $4\pi r^2$. So, the total surface area of the four spheres will be:

$4\pi (r^2/4 + r^2 + 4r^2 + 9r^2) = 57\pi r^2$.

The answer is therefore **C**.

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Question 58: E

To calculate the original price we must calculate the discount as a decimal, which in this case is 0.2. Then, we must divide the new price by (1 – the discount). 32/0.8 = 40, so **E** is correct.

Question 59: D

If the bar repels the magnet, then it is likely to be magnetised itself. The earthed magnet will therefore repel a bar of magnetised steel. Therefore, **D** is the most likely answer.

Question 60: C

Y is the total current flowing in the circuit. Current = voltage/resistance. The resistors in parallel have a total resistance (Rt) given by:

1/Rt = ¼ + ¼

Therefore, Rt = 2.

The total resistance in the circuit is 4 + 2 = 6 Ohms.

Therefore, Y = 12/6 = 2.

The current flowing through X will be half that of Y, so X = 1.

There will be 1A of current flowing the resistor in parallel with Z. Therefore, this will have a voltage of 4V, meaning the voltage at Z will be 8V. The answer is therefore **C**.

END OF PAPER

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2015: SECTION 1

Question 1: B

The passage is referring to why there may be a lack of carbon closer to the sun, and therefore why it is such a mystery that life can form so close to the sun. Any statement that mentions how there may have been carbon this close to the sun, such as in an asteroid belt, would strengthen the argument. Therefore, **B** is correct.

Question 2: D

The cheapest standard price card that Tom can get that are the correct measurements cost €1.50. The cheapest deluxe price card that he can get is €1.95. If he needs 50 of these, it will either cost him €75 for the standard cards or €97.5 for the deluxe cards, meaning the extra would be €22.50. The answer is therefore **D**.

Question 3: D

The passage refers to how while it is amazing that life has evolved on this planet, it may not be a coincidence, as the observer is the one who can wonder about their existence. Therefore, it would not be a coincidence if we were the only the life within the galaxy, so **D** is the main conclusion of the passage.

Question 4: C

First, we must work out the total area of the walls that need to be painted. 4 x 6m for the ceiling, 2 x 6 x 3.5m for the long walls and 2 x 4 x 3.5m for the short walls. The window is $3m^2$. Therefore, the total area to be painted is $91m^2$. $18.2m^2$ will also need a second coat, therefore enough paint needs to cover $109.2m^2$. Consequently, a minimum of 5 cans will be needed, so the answer is **C**.

Question 5: E

While encouraging gardening may be beneficial to children for whatever reason, if they have not gained an interest in the gardening itself, then they are unlikely to think further about growing food and the impact that junk food may have on their health. Therefore, **E** would weaken the argument.

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Question 6: E

In distance-time graphs, the gradient shows the speed. If he is slower to start with and then speeds up halfway through, the graph to show Leroy's journey is **E** where the first half of his journey takes 3 times as long as the second half as he is going 3 times slower to start with.

Question 7: C

The fluoridation of the water mentioned in the passage may well be beneficial to dentition. The problem with the passage is that the problems with fluoridation are only expressed in one family's experience. There is no evidence that the symptoms they express is because of the fluoridation, thus this is an assumption in the passage, so the answer is **C**.

Question 8: B

The premise of the passage is along the lines of guilty until proven otherwise. This can easily be translated into statement **B**, where a terrorist is guilty until proven otherwise, to ensure that they do not commit any more atrocities if they are indeed guilty.

Question 9: D

In order to make the sum of the first three 2-digit odd numbers less than 100 (so that it is 2 digits), 1 and 2 must be the 3rd and 5th numbers, respectively. Taking the first numbers to be 43, neither the 4th or 6th numbers can be a 7, since the addition of 7 and 3, results in 10, meaning the other odd number would have to be repeated in the final two digits. Thus, the final digit must be a 7 and the sequence is 4 3 1 5 2 9 8 7. The answer is therefore **D**.

Question 10: A

The passage refers to how animals are able to adapt to climate change. Whilst great tits may have adapted over the last 50 years to lay their eggs earlier in the year, this does not mean caribou in the Arctic will be able to do the same. Thus, **A** is the assumption made in the argument.

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Question 11: E

The cerebellum of a cat takes up roughly 0.0015% of its body weight. For the mouse, this is 0.0016. For the pigeon, this is 0.00008. For the squirrel, this is 0.0043. For the rabbit, this is 0.0011. For the dog, this proportion is 0.0017. Therefore, the mouse is closest the cat in terms of ratio of cerebellum weight to body mass and so the answer is **E**.

Question 12: D

The passage states that a person will play sport to either get exercise or for a competitive reason. Since there is little exercise in pool, the main reason people play it is for the competitive aspect, thus **D** is correct.

Question 13: D

The easiest way to answer this question is to draw out the number plate as it would be seen upside down, and then backwards as it would be seen in the rear-view mirror. This will give the answer **D**.

Question 14: E

The passage is against increasing the speed limit and claims whilst the congestion on roads would be the same, the speed of traffic would increase, which would only put people in more danger. Therefore, the correct answer is **E**.

Question 15: A

The passage is arguing that while one option may be beneficial to some people who need it, it is not necessarily beneficial to those who do not need it. Therefore, the principle is similar to that in statement **A**, where though fluoridation would improve tooth decay in people who have tooth problems, it may not be beneficial for the general public if they do not have tooth problems.

Question 16: A

The hovercraft will have been going for 1 hour 10 minutes when it reaches Genville for the first time. On its way back it is moving double as fast as the ferry, which has completed 70% of its journey. Therefore, they will meet when the ferry has completed 80% of its journey and the hovercraft has completed 20% of its journey back. This will be after 1 hour and 20 minutes, so the answer is **A**.

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Question 17: A

If we sum all of the lengths between the outside poles, it comes to 10.75 m. Therefore, we need 4.48 sets of rails, meaning 5 is the minimum number of rails that the farmer can use, and so the answer is 5.

Question 18: E

The passage describes how police going undercover to prevent future crimes, may not be acceptable, if they have to commit crimes themselves to get to that point. The expression that is an underlying principle to this argument is the end does not justify the means and therefore **E** is correct.

Question 19: D

Over the whole time, Deanna covers 1,946 km and adds 140 litres, but 18 of these litres are filled on the last day so cannot be included. Therefore, she uses 122 litres to travel 1,946 km, so every 100 km, she uses roughly 6.5 litres. Since we cannot be sure how many litres of fuel she started with, the best estimate for her fuel consumption is **D**.

Question 20: C

As there must be 1m of space around the tables, they must fit in a 4m by 4m space. This rules out **B** and **E**. Since the tables are 1m wide and the display cases are only 0.2m wide, the best space saving mechanism is to double them up longitudinally on each table. This will only be possible in **C**. Two cases can fit on the left and right tables facing out, and one facing in on each of the same tables. Then one can fit facing down over the middle table and two can fit facing up because the cases are only 0.2m wide, making a total of 9. Therefore, the answer is **C**.

Question 21: D

Pedagogy is the practise of teaching. It involves the actions of teaching and making informed judgements by taking into account the understanding of the student and the theories of learning. Max Weber was a philosopher and not a teacher, so the answer is **D**.

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Question 22: D

Mahatma Gandhi was an Indian activist who led the movement against the British rule. Whilst Gandhi has a peace prize named after him, the International Gandhi Peace Prize, he was never awarded the Nobel Peace Prize.

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SECTION 2

Question 23: C

LH and FSH peak during ovulation in the menstrual cycle. Just before ovulation, the concentration of progesterone is rising, and the concentration of oestrogen is falling. The answer is therefore **C**.

Question 24: D

During a motor response, a signal is sent to the muscle cells, resulting in calcium ions being released from the sarcoplasmic reticulum (**5**). Then this reveals the myosin binding sites on the actin, so the myosin heads can bind (**1**). The myosin heads then cause a contraction by pulling down the actin before they release ADP and phosphate (**2**). The myosin heads then detach from the actin (**4**) before the process is repeated. Therefore, the correct answer is **D**.

Question 25: B

There are four possible phenotypes produce by the crossing of QqRr and QqRr. If the dominant allele is present, that will produce a phenotype identical to the phenotype from a heterozygous genotype. The different phenotypes can be caused by Q and R, Q and rr, qq and R or qq and rr, so the answer is **B**.

Question 26: B

After three rounds of replication, there will be 12.5% of the original DNA, since with each replication the original DNA content halves relative to the new DNA. Therefore, the answer is **B**.

Question 27: C

During the photolysis of water as part of photosynthesis, oxygen is produced directly as well as protons and electrons. Carbon dioxide is not produced during photosynthesis and is in fact a key reactant in the reaction. Therefore, **C** is correct.

Question 28: A

A stem cell will have the same genetic makeup of a nerve cell so will be Aa. At the start of mitosis, the DNA replicates so the alleles will be AAaa, which will remain until after meiosis I, so **A** is correct.

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Question 29: B

When a sarcomere contracts, the actin is pulled closer towards the myosin, meaning 1 will get smaller. However, the size of the actin does not actually change, so **2** will stay the same size. Therefore, **B** is correct.

Question 30: C

In an amino acid, the variable group is a group that is not the carboxyl group or the amino group or hydrogen, which is **2** in this case. The acidic group can donate a proton, which is the carboxyl group or number **3**. The answer is **C**.

Question 31: D

Osteocytes are mature osteoblasts and are therefore found in the bone tissue. They make up a large proportion of the cellular component of bone, along with the collagen-rich extracellular matrix. **D** is correct.

Question 32: B

The probe will fluoresce if it has a complimentary DNA sequence to the human DNA. **2** will bind to GATTAT and **3** will bind to TGGTCA, both of which are present in the original DNA sequence, therefore **B** is correct.

Question 33: E

X represents the left atrium contracting. This means blood will be leaving the left atrium and entering the left ventricle. The semi-lunar valve in the aorta will be closed as the ventricle is filling. The muscles of the left ventricular wall will be relaxed to allow for filling. Therefore row **I** and option **E** are correct.

Question 34: E

During mitosis, the DNA replicates then the chromosomes line up in the equator, before spindles attach and shorten thus separating the DNA into different cells. The nuclear envelopes can then reform and the cytoplasm and its contents split into the two cells. **E** is the correct answer.

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Question 35: A

Glucagon is not a carbohydrate; it is a peptide hormone. It is released by alpha cells of the pancreas in response to low glucose levels in the blood, in order to facilitate the release of carbohydrates into the blood for tissues that need glucose for respiration (such as the brain). The answer is therefore **A**.

Question 36: C

By making it more difficult to open sodium channels, there is a lower chance of the membrane of a nerve cell being depolarised to cause an action potential. Therefore, **C i**s correct.

Question 37: E

Ribosomes are very small within the cell. The nucleolus is relatively large and can be seen with a relatively low power microscope. Mitochondria require a slightly higher power microscope to be seen, thus **E** is the correct answer.

Question 38: C

Transcription in prokaryotes occurs in the cytoplasm, as they do not have a nucleus. Translation occurs in ribosomes, but neither in the mitochondria, therefore **C** is correct.

Question 39: C

Since the key refers to the tRNA triplets, this will be identical to the mutated DNA, except the thymine will be replaced will uracil. Thus the sequence of interest will be AUC UUG CGG and the amino acid sequence will look like **C**.

Question 40: D

Evolution involves the mutations of genes and the variation in combinations of genes, which can increase biodiversity and eventually lead to speciation. Therefore, **D** is correct.

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SECTION 3

Question 41: C

We need to use the equation moles = mass/M_r for this question.

We therefore have 0.6/12 = 0.05 moles of carbon.

Therefore, we have 0.05 moles of the hydrocarbon so 0.05 = 0.75/M_r.

M_r = 15, so there must be 3 hydrogen atoms relative to the number of carbon atoms, so the only suitable formula is C_2H_6, and so **C** is correct.

Question 42: E

24.6 g of 1-bromopropane is equal to 0.2 moles. 8 grams of propan-1-ol is equal to 8/60 moles = 0.13. To calculate percentage yield, we divide the actual yield by the predicted yield.

Therefore, 0.13/0.2 x 100 = 66.7% and the answer is **E**.

Question 43: D

The concentrations of H^+ and OH^- will always be the same, since they are formed from just one reactant. Increasing the temperature will favour the endothermic side, therefore more H^+ ions will be present, and the pH will fall. However, the electrical conductivity will not be changed by changing the temperature, as the number of free electrons will remain the same. Therefore, the answer is **D**.

Question 44: D

Aluminium has 13 electrons, therefore Al^{2+} will have 11 electrons. The S orbitals will contain 5 electrons between them. Since the 2p orbital can take 6 electrons, the answer is **D**, not **E**, and the configuration will be $1s^2\ 2s^2\ 2p^6\ 3s^1$.

Question 45: C

For XY_2 to form, the valency of X must be double that of Y. If X has the atomic number 12, then its valency will be 2, and if Y has atomic number 9, then its valency will be 1. X will want to lose 2 electrons and Y will want to gain an electron. Therefore, **C** is correct.

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Question 46: E

The boiling point of organic compounds increases if the chains in the molecules are longer and less branched. This is the case for pentane, in comparison to 2,2 – dimethylpropane, as pentane has a longer chain and less branches, which result in more induced dipoles. This results in stronger intermolecular forces, so **E** is correct.

Question 47: C

NH_4 will have an overall oxidation number of +1. If Cr has an oxidation number of +6 and two NH_4 groups are present in the molecule, then the rest of the atoms in the molecule need to give an oxidation state of -8, therefore 4 oxygen atoms are needed and the formula for the molecule is $(NH_4)_2CrO_4$. The answer is **C**.

Question 48: E

Propanal is an aldehyde of propane, which has 3 carbons in the chain and an aldehyde group at the end. Therefore, the molecular formula is CH_3CH_2CHO and the answer is **E**.

Question 49: D

First, we must write the equation for this reaction:

$C_3H_7OH + O_2 \rightarrow H_2O + CO_2$

To balance it, we should try to balance the carbons, meaning $3CO_2$ will be produced. If there are 8 hydrogen atoms on the left, then we need $4H_2O$ molecules. However, this leaves 10 oxygen atoms on the right, meaning we would need $4.5O_2$ on the left to balance the equation. Therefore, we double everything to give:

$2C_3H_7OH + 9O_2 \rightarrow 8H_2O + 6CO_2$

The ratio of CO_2 to H_2O is 3:4 and the answer is **D**.

Question 50: D

In the original solution, there will have been 60g of potassium nitrate dissolved in the solution. To fully dissolve this amount at the lower temperature, there must be 60/50 x 100g water = 120g. Therefore, 70g must be added to the solution to allow for all the potassium nitrate to dissolve and the answer is **D**.

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Question 51: E

CO_2 reacts with water to give H_2CO_3. SO_2 reacts with water to give H_2SO_4. Both of these are acidic solutions, so CO and NO would not give acidic solutions in water and the answer is **E**.

Question 52: D

When a halide is dissolved in water, the resulting solution is not basic. Likewise, ethanoic acid (**E**) is acidic when dissolved in water. Sodium carbonate will be basic in water and therefore have a pH > 7.0, so the answer is **D**.

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SECTION 4

Question 53: A

$2 \log_{10}(x)$ can be written as $\log_{10}(x^2)$.

$\log_{10}(x^2) - \log_{10}(y) = 3$, $\log_{10}(x^2/y) = 3$

Exponentiating to rule out the logs leaves:

$x^2 / y = 1000$, therefore $y = x^2 / 1000$ and the answer is **A**.

Question 54: E

In this question, we need to find the option where the formulas on the right-hand side will equal those on the left-hand side. We know that current = voltage/resistance and we also know that current = charge/time. Therefore, it is possible to summate $(V/R_1) + (Q/t)$, so the answer is **E**.

Question 55: A

From the second equation, we know that $y = 2x - 5$. Subbing this into the top equation leaves:

$7x - 15 = 13$, so $x = 4$. Therefore, $y = 3$, so $x + y = 7$ and the answer is **A**.

Question 56: D

The centripetal force of an object moving in a circle is the resultant force that causes the object's acceleration and is always towards the centre of the circle, in direction R. We therefore must choose between **A** and **D**. The centripetal force is mv^2/r, which is equal to 18,000N or 18kN. Therefore, the answer is **D**.

Question 57: D

$(a + b + c) / 3 = 8$ so $a + b + c = 24$

$(a + b + c + 12) / 4 = y$

Therefore, $y = 36/4 = 9$, so the answer is **D**.

Question 58: B

$(729 - 529) + (196 - 36) = 200 + 160 = 360$, so the answer is **B**.

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Question 59: D

For this question we need to use the following equation:
Energy = mass x specific heat capacity x temperature change.
Therefore, specific heat capacity = energy / (mass x temperature change)
This is equal to 9000 / (2.5 x 4) $J\ kg^{-1}\ K^{-1}$
The answer is therefore **D**.

Question 60: E

If there are two forces acting on a beam, the magnitude of the torque acting on the beam will be the two forces combined. Therefore, since the forces act at the end of the beam and the pivot is in the middle:
Torque = 2 x (F x d) / 2 = F x d
The forces must be acting in opposite directions, leaving **B** and **E**. It cannot be **B** because there would be no moments present since the forces are parallel to the beam, therefore the answer is **E**.

END OF PAPER

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2016: SECTION 1

Question 1: C

In this question, the key is to look for the tiles in the corners of words. S has four of the specified tiles that we are looking for, P has three of these, etc. The total is 17 and the answer is **C**.

Question 2: E

To maximise efficiency, ideally, we want a worker to do exactly 16 hours. Therefore, one worker can do operations A and H, one can do E and G, one can do I, F and H. This leaves B, C, and D, which cannot be done by one single worker, therefore 5 workers are needed, so the answer is **E**.

Question 3: A

The tins can either be all red or all blue. They can also either have one blue or one red side. Finally, the tins can either be made up of adjacent red signs and therefore adjacent blue sides, or alternating red and blue sides, a total of 6 types of tin. The answer is **A**.

Question 4: A

If 17 skiers went before her in the second round, and she was the 6th last to ski, then 23 skiers raced in the second race. If three fell in the first race, then 26 competed overall and the answer is **A**.

Question 5: B

The passage claims that recognising touched objects by sight improved within days. This means that the behaviour is learnt and not necessarily innate. Therefore, **B** is correct.

Question 6: B

The small van driver's shifts take 1 hour 10 minutes. If the small van driver gets back as late as possibly can, then each shift from 1pm will start at 11:50, 10:40, 9:30, 8:20 and 7:10. The depot doesn't open until 8:20, so the latest he can start is 8:20, 20 minutes later than the large van driver, so the answer is **B**.

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Question 7: B
54% of 250 is the same as 125 + 10 = 135.
2% of 250 is equal to 10.
17% of 250 is equal to 50 – 7.5 = 42.5.
250 + 135 + 10 + 42.5 = 432.5kg, so the answer is **B**.

Question 8: B
To have at least 20g protein, ham, salad and tuna sandwiches are ruled out. Chicken is ruled out as it has over 4g fat. Therefore, the cheapest of beef and turkey is £2.00, so the answer is **B**.

Question 9: E
The passage states that to learn a first language, we do not need to be exposed to grammar. It then also claims that therefore, to learn a second language, we do not need to be exposed to grammar; we only need exposure to the target language. This assumes that first and second languages are learnt in the same way, so the answer is **E**.

Question 10: A
In this question it is useful to draw the 6 tiles separately and look through each answer to confirm if they contain each tile. Doing this will show that the tiles are in pairs, so we are only looking for 3 different types of tile, each repeated. From this, we can work out that the answer is **A**.

Question 11: D
The passage expresses the importance of playing to help a child develop the ability to think rationally. Therefore, it concludes that children must be allowed to play so that these thinking skills can develop, so the answer is **D**.

Question 12: C
The passage is expressing concern about how advancements in bio-technology could be beneficial, but also how we do not know where it will lead us. Therefore, it is better is the advancements stick to what nature intends to ensure the progress does not get out of hand. The conclusion is therefore **C**.

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Question 13: E

The centre of the piece of paper could be in each corner of the smaller square. If the centre is the top right corner, then **C** is produced. If the centre is the top left corner, then **D** is produced. If the centre is the bottom right corner, then **B** is produced. If the centre is the bottom left corner, then **A** is produced. Therefore, unfolding the paper cannot produce **E**.

Question 14: D

The passage assumes that the life expectancy in the USA is lower than other countries because of poor diet and lack of exercise. Therefore, if another factor contributed to the poor health of Americans, then this would weaken the argument. Therefore, claiming the highest percentage of smokers in the 60s and 70s was in the USA would weaken the argument, so the answer is **D**.

Question 15: B

The passage assumes that all bovine TB was initially caused by the spread from badgers. It does not confront the fact the bovine TB was spread between cattle and that other precautions to reduce the spread of the disease could have been taken. Therefore, **B** would weaken the argument in the passage.

Question 16: C

For this question, the locations must be a maximum of 2 hours apart. In March, New York will be one hour forward and would read 11:37. Santiago on the other hand would be one hour behind the time it is currently at and so would also read 11:37. Therefore, the answer is **C**.

Question 17: C

The final sentence of the passage concludes it well, stating that healthier foods that are easier to prepare should be a solution for childhood obesity. These should be more readily available; therefore, the answer is **C**.

Question 18: B

The passage does not state why more donor organs are needed. The reason is because the number of organs that are donated is small and is not increasing, which would strengthen the passage if this fact were included. Therefore, the answer is **B**.

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Question 19: E

The passage explains how using female models is a concern for women around the globe as the body types are often unrealistic. It explains that using male models may make females less worried about trying to attain such a body type. Therefore, any statement that supports women not wanting to attain this body image would support the argument, so the answer is **E**.

Question 20: D

This passage refers to how people who are more respected in society can make a big difference by setting an example to those who look up to them. This principle could be applied to directors of companies demonstrating good actions such as recycling in front of their employees to encourage the employees to do the same. Therefore, **D** is correct.

Question 21: C

There were 12 founding members of NATO: Belgium, France, Luxemburg, Canada, UK, USA, Denmark, Iceland, Italy, Netherlands, Norway and Portugal. Therefore, Germany was not one of the founding members of NATO.

Question 22: D

Construction for the Parthenon of Athens began in 447 BC and took 9 years to complete. It was a temple built during the peak of the Athenian Empire. However, it is not one of the Seven Wonders of the Ancient World, so the answer is **D**.

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SECTION 2

Question 23: E

The only organelle in the list that contains RNA but not DNA is the ribosome. This is because the ribosome contains rRNA in its structure, and also mRNA and tRNA for protein synthesis.

Question 24: E

This question is referring to mitosis, where the DNA in the subsequent two cells created form one cell is identical. Therefore, in the cells produced there will be all four alleles: E, e, R and r. This means that **6** and **7** are the only possible options, so the answer is **E**.

Question 25: C

tRNA is present in the ribosome and is therefore not involved in transcription. mRNA is involved in both transcription and translation. DNA is only involved in transcription. Therefore, row **1** is correct and the answer is **C**.

Question 26: A

Uracil is not found in DNA, which rules out rows **2**, **3** and **5**. DNA and tRNA molecules contain pentose sugars, adenine, hydrogen bonds (between bases) and phosphodiester bonds (between nucleotides). Therefore, row **4** is correct and the answer is **A**.

Question 27: C

Genetic drift and mutations can both occur randomly as they are natural processes. Artificial selection is not natural; therefore, it can never be random, so the answer is **C**.

Question 28: E

To produce a transgenic plant, a plasmid must be taken, and restriction enzymes must reveal the sticky ends (**Z**). Then the required gene must be isolated (**W**) and mixed with the plasmid (**V**). The recombinant plasmid must be identified and isolated (**X**) before the plasmid can be injected into the host plant (**Y**).

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Question 29: A

E. coli is a bacterium and is smaller than a plant or animal cell. Red blood cells are quite small, as they need to fit through tiny capillaries. Onion epidermal cells are larger. Therefore, **A** is the correct answer.

Question 30: D

Bile is produced by the liver and then sent to the gall bladder for storage before it is used to emulsify fats in the small intestine. The answer is therefore **D**.

Question 31: A

The bases are complementary to the bases A A C G A, in the order 1 2 3 4 5. Since this is DNA, thymine is present rather than uracil. Therefore, the sequence is T T G C T, and the answer is **A**.

Question 32: A

The heart rate is controlled by the medulla oblongata, situated in the brainstem at **I**. From here the heart rate and force of contraction can be altered in order to regulate blood pressure. The answer is **A**.

Question 33: C

An amino acid is composed of a core hydrocarbon chain, with a carboxyl group and an amino group attached. To form two of these, bond **3** must be broken. The answer is **C**.

Question 34: D

An enzyme provides an alternative pathway with a lower activation energy for a reaction and does not change composition during the reaction. FAD, acetyl coenzyme A and reduced NAD are all products/reactants of respiratory reactions.

Question 35: D

Before meiosis can begin, the diploid cell must double its DNA content. This results in the total number of chromosomes at the end of meiosis II being double that of the original diploid cell. At the start of meiosis II, the daughter cells are ready to split, but they already have half the number of chromosomes as the original diploid cell and are therefore considered haploid, so the answer is **D**.

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Question 36: D

Sodium channels open to cause depolarisation of the cell and therefore the firing of an action potential. They are open during phase **2**, where sodium ions enter the cell to make the cell potential difference more positive, so the answer is **D**.

Question 37: E

The phenotype is the characteristic that a gene expresses. If the expression of a certain allele is dominant, then the phenotype will be either caused by that allele, or there will be a different phenotype if the dominant allele is not present. Therefore, for the RrTt x RrTt cross, there can be four phenotypes produced: if either R or r is present and if either T or t is present. This is the same for the RrTt x rrtt cross, since there are still two dominant alleles. Therefore, there is no difference in the number of possible phenotypes that can be produced by the two genetic crosses, and so the answer is **E**.

Question 38: C

The light-dependent photosynthesis reactions occur in the granum, where NADP is used as the hydrogen carrier and it ends up being reduced. The answer is therefore **C**.

Question 39: B

During phase two (metaphase), the chromosomes line up in the cell (but not in homologous pairs). During phase four (telophase), the nuclear envelope reforms to contain the DNA. Therefore, row **I** and **B** are correct.

Question 40: E

Carbohydrates are used in mitochondria for respiration. In chloroplasts, the carbohydrates are a product of photosynthesis. In the Golgi apparatus, proteins undergo post-translational modifications, where carbohydrate groups can be added to form glycoproteins.

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SECTION 3

Question 41: B

Na_2CO_3 will give off CO_2 and leave an alkaline solution. NaCl will not change the pH of the solution since it is essentially just salt. $NaHSO_4$ will make it acidic due to the release of protons into the solution. The answer is therefore **B**.

Question 42: D

The valency of lead is 2 and iodine is 1; therefore, Pb^{2+} will react with $2I^-$ to form PbI_2. Both the lead and iodine initially react as aqueous solutions. However, they combine to form a solid precipitate. The answer is **D**.

Question 43: A

The CHO group at the end is an aldehyde, and the CO in the middle is a ketone. There is also a CH_2CHCH_2, which represents an alkene, as there is a double bond between two of the carbons. Therefore, the answer is **A**.

Question 44: E

1 has 10 electrons, 2 has 10 electrons, 3 has 18 electrons, 4 has 10 electrons and 5 has 2 electrons. Therefore, **1**, **2** and **4** have the same electronic configuration, so the answer is **E**.

Question 45: D

Adding more water will favour the left-hand side of the reaction. Increasing the temperature will favour the endothermic side, which is the left-hand side. Adding sodium hydroxide will react with the ethanoic acid so that less methanol reacts, therefore increasing the amount of methanol. Adding a catalyst will favour the right-hand side. **1**, **2** and **3** will all increase the amount of methanol; therefore, **D** is correct.

Question 46: A

The intermolecular forces between CO_2 molecules are very weak, meaning CO_2 has a very low boiling point. Ethanol has a polar carbon-oxygen double bond, meaning it can form stronger intermolecular forces than alkanes such as propane. The order of increasing boiling points is therefore carbon dioxide, propane and then ethanal, meaning the answer is **A**.

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Question 47: E

The equation we need in this question is moles = mass/M_r.
The M_r of lithium hydroxide is 7 + 16 + 1 = 24.
In 1 litre, the mass of LiOH will be 0.1 x 24 = 2.4g.

Question 48: E

The concentration of OH^-, assuming complete dissociation, will be 0.01 mol/L. Subbing this into the K_w equation gives:
$10^{-14} = [H^+] \times 0.01$, so the H^+ concentration is 10^{-12}, meaning the pH is 12. The answer is **E**.

Question 49: E

In this question we are trying to identify where the fluorine atoms fit into the straight chain 4-carbon molecule. There can be two F atoms on carbon-1 or two on carbon-2. Carbon-1 can then have one F atom and carbon-2 can have one F atom. Carbon-2 can have one F atom and carbon-3 can have one F atom. Carbon-1 can have one F atom and carbon-3 can have one F atom. Finally, carbon-1 can have one F atom and carbon-4 can have one F atom. This is a total of 6 structural formulas, so the answer is **E**.

Question 50: D

This ion will have 24 protons, as the atomic number is 24. It then has a charge of 3+, meaning it has lost 3 electrons, so will have 21 electrons. The mass number is the number of protons + neutrons, meaning there are 28 neutrons. Therefore, **D** is correct.

Question 51: B

$BeCl_2$ will have a bond angle of 180° because the two chlorine atoms will repel each other so they are as far away from each other as possible. Likewise, the hydrogen atoms will do the same in C_2H_2 – the only difference will be the double bond between the carbon atoms. CCl_4 has 4 chlorine atoms attached a central carbon atom and will therefore have a more tetrahedral shape. The answer is therefore **B**.

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Question 52: B

Oxygen has an oxidation state of -2. Therefore, in the first ion, the oxidation state of vanadium will be +5, to make a 1- charged ion. The oxidation states of **2** and **3** are +3 and +2, respectively. **4** has an oxidation state of +4, whereas **5** has an oxidation state of +5. The answer is **B**.

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SECTION 4

Question 53: C

The length of one of the shorter sides is y and the other is 2y. Therefore:
$2y^2 = 18 \times 2$ (as it is the area of a triangle not a square), so $y = \sqrt{18}$
The length of the hypotenuse of a right-angled triangle (L) is given by:
$L^2 = (\sqrt{18})^2 + (2\sqrt{18})^2 = 18 + 72 = 90$.
Therefore $L = 3\sqrt{10}$, so the answer is **C**.

Question 54: E

Force can be measured in energy/distance. A unit of energy is the joule, whereas a unit of distance is the metre. Therefore, joules per metre can be a unit of force. The answer is **E**.

Question 55: A

$x^2 - 1 = (x+1)(x-1)$, thus the solution can be written as:

$$\frac{2}{(x+1)(x-1)} - \frac{1}{(x-1)}$$
$$= \frac{2(x-1) - (x-1)(x+1)}{(x+1)(x-1)(x-1)}$$
$$= \frac{2 - (x+1)}{(x+1)(x-1)}$$
$$= \frac{1-x}{(x+1)(x-1)}$$
$$= \frac{-(x-1)}{(x+1)(x-1)}$$
$$= -\frac{1}{(x+1)}$$

Question 56: A

If $x = 0$, then $y = 6$. If $y = 0$, then $x = 4$. Therefore, the points of the line intersecting the axes are (0, 6) and (4, 0). The centre of the circle must lie between these two points, if A and B lie on the edge of the circle and the diameter of the circle is AB. Thus, the centre of the circle is (2, 3) and the answer is **A**.

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Question 57: E

The maximum resistance uses all three resistors in series, summing to a total of 18 Ohms. To minimise the resistance, the resistors must be connected in parallel.
1/resistance (total) = 1/R1 + 1/R2 + 1/R3.
Therefore, 1/Rt = ½, so the minimum resistance is 2 Ohms. The answer is **E**.

Question 58: A

The forces going up must equal those going down. If the force from the left support is a and the force from the right support is b, then a + b = 800N.
Then, if we choose the point where b is, from there the moments going up must equal the moments going down.
Therefore, 5a = 500 + (300 x 4), thus a = 340N and b = 460N. The answer is therefore **A**.

Question 59: E

As a ball goes up it gains gravitational potential energy but then slows down and therefore loses kinetic energy. However, the acceleration of the ball as it goes down is constant. At the ball's maximum height, there are vertical forces acting on the ball which cause it to move downwards. Therefore, **E** is the correct answer.

Question 60: E

$xy = 3 \times 5 \times 10^m \times 10^n$
$= 15 \times 10^{m+n}$
$= 1.5 \times 10^{m+n+1}$

END OF PAPER

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2017: SECTION 1

Question 1: D

After the tin has been passed round 6 times, 24 red chocolates have been taken, 6 blue, 18 green and 12 yellow. Therefore, a total of 60 chocolates have been taken, ruling out **A**, **B** and **E**. If we presume **D** is the correct answer, there will be 36 chocolates left in the box, half of which are blue, meaning there are 18 blue chocolates left. Add this to the 6 that have already been taken makes 24 blue chocolates. That would leave 6 green and 12 yellow chocolates uneaten, which would make up the other 18 chocolates left in the box; therefore, the answer must be **D**.

Question 2: E

Viewing the window frame from the top will give **B**, from the left will give **D**, from the bottom will give **C** and from the right will give **A**. Therefore, **E** is not a view that can be seen side on to the window frame.

Question 3: B

The senior manager is Prague will see the email as soon as it is sent out. If it is sent at 3pm, the person who will read it last will have just got off work at this point and will therefore be 3 hours ahead. This will be the senior manager in Moscow. They will get the email at 6pm but will not read it until 8am the next day, a time of 14 hours. Therefore, the answer is **B**.

Question 4: E

All single packages would cost £3.85. 3 double packages and a single would cost £2.65. A double and a 5-item package would cost £2.30. The cheapest option, however, is a 4-item and a 3-item package, costing £2.25, so the answer is **E**.

Question 5: A

The square wardrobe must be on the right of the door in the corner, ruling out **B**, **C** and **D**. The long bed is on the same side as the square wardrobe, leaving **A** to be the only correct answer.

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Question 6: A

For a grid of 100 squares, there must be 10 matchsticks running horizontally, but 11 sets of these horizontal matches are needed for the whole grid. There must therefore be 11 matches running vertically, with 10 sets of these matchsticks required. Thus, 110 + 110 matchsticks are needed so the answer is **A**.

Question 7: E

We are looking for a conclusion to the passage that states using e-cigarettes is a good way for people to quit smoking, but that we do not fully understand how damaging using just nicotine is, and therefore we should not assume that e-cigarettes are safer than traditional cigarettes. As a result, the answer is **E**.

Question 8: A

The problem with palm oil plantations is that large areas of forest must be knocked down in order to create space for these plantations. This passage expresses concern about the use of palm oil plantations but also states that alternative vegetable oil crops are also not ideal and that banning palm oil plantations may not solve the problem. Therefore, **A** is a conclusion that can be drawn from the passage.

Question 9: A

David spends 1 hour + 20 minutes + 1 hour + 20 minutes + 30 minutes getting to Carston, meaning he arrives there at 14.10 and has a 50-minute wait before returning to Ardale. These are distance-time graphs, meaning the gradient is the speed. His speed will be slow for an hour, and then stop for 20 minutes, then speed up for an hour before stopping for 20 minutes. He then speeds up for half an hour before stopping for 50 minutes and cycling home in 50 minutes. **A** is the only graph that represents these facts.

Question 10: E

The problem with this argument is that it states that the experience of only one user with one company should make you think twice about using these comparison websites. One person may have had a bad experience, but it does not mean all comparison websites are useless, therefore the answer is **E**.

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Question 11: E
This argument states that trawling is actually beneficial to ecosystems. Therefore, a statement about how trawling is actually damaging to the environment would weaken the argument. Consequently, **E** is the correct answer.

Question 12: A
Nowhere in the passage does it give a reason for how the actions of the captain may affect the rest of the team. It is quite reasonable to assume that his actions may well affect team morale, but this is an assumption all the same, therefore the answer is **A**.

Question 13: E
The puppy runs 3 times as far as Luke. Therefore, after Luke walks 1km, the puppy will have run 3km. If this takes 12 minutes, in an hour the puppy will have theoretically run 15km, in a speed of 15km/h; therefore, **E** is the correct answer.

Question 14: B
While more people may be studying in forensic science related courses, and there may well only be the same number of jobs as before, the argument does not refer to how studying on such a course may provide skills to the person. This could lead to them being better suited to other jobs that are not in the forensic science field; therefore, **B** is true.

Question 15: E
Harry burns 155 calories walking fast and 100 calories walking slow, a total of 255.
Holly burns 170 calories running fast and 25 calories walking slow, a total of 195.
Jessie burns 90 calories running fast and 140 calories running slow, a total of 230.
Josie burns 175 calories walking fast and 120 calories walking slow, a total of 295.
Paul burns 120 calories running slow and 70 calories walking fast, a total of 190 calories.
Therefore, the answer is **E**.

Question 16: C
The problem with this passage is that it is assumed the extra insurance that the banks want customers to buy is only useful for protecting against the costs of fraudulent credit card transactions. The extra insurance will actually cover many other claims that are not mentioned in the passage, so **C** is correct.

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Question 17: D

The passage expresses that sales taxes on fuels should be used within the transport industry. The money doesn't just need to be used on repairing roads and benefitting car drivers, but also for public transport. An equivalent principle is **D**, where sports events profits should be used for funding grass roots sports to increase participation.

Question 18: D

This passage explains that most of the time, the reason that underprivileged children do not have glasses when they need them is because the parents of the child cannot afford them. The passage states that the government should help to fund underprivileged children's glasses in order to give them a better chance at school. Therefore, a conclusion that can be drawn from the passage is **D**.

Question 19: E

While the passage states that drinking these alcohol-based liquids resulted in the decline in young people's health, it did not discuss how alcohol also has a poor impact on young people's health. Therefore, the flaw in the argument is how if the restrictions were lifted, the alcohol would still impair young people's health, so the answer is **E**.

Question 20: C

Here, we need see whether it is quicker to go to Arundel or Chichester first. If he goes to Arundel first, he will get there at 9:32 and be ready to leave by 13:32, meaning the first train he can get to Chichester will be at 14:02, arriving at 14:24. He will stay in Chichester until the first train after 18:24, which is at 18:37, therefore arriving at 20:20. However, if he goes to Chichester first, he will be ready to leave for Arundel on the 13:41. Four hours in Arundel means he can catch the 18:13, which arrives back in Victoria at 19:47. The answer is therefore **C**.

Question 21: E

The actions of someone to intentionally benefit them, but that also come with unintentional social benefits, were termed the "invisible hand" by Adam Smith. He used it to describe income distribution and production in the 18th century.

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Question 22: E

Einstein's general theory of relativity was announced publicly to the Prussian Academy of Science on 25th November 1915, before being published in 1916. It is considered one of the greatest achievements of 20th century physics.

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SECTION 2

Question 23: D

Before meiosis can occur, the DNA of a gamete must replicate, thus doubling the DNA content of the cell. Only then can the two rounds of meiosis occur, where spindles form and there is crossing over of DNA. The answer must therefore be **D**.

Question 24: C

Peptide bonds occur between amino acids and so are present in all proteins. The capsid, envelope and reverse transcriptase all contain amino acids with peptide bonds between them, as they are made up of proteins; therefore, the answer must be **C**.

Question 25: A

During oogenesis, the gamete only becomes haploid, with half the amount of DNA as a diploid cell after it forms a secondary oocyte from a primary oocyte. Therefore, the rest of the cells in the process are diploid. The answer is therefore **A**.

Question 26: A

Some enzyme inhibitors can work by blocking the active site, but they do not denature the enzyme, so the answer cannot be **1** or **2**. Inhibitors do not affect the activation energy of the reaction as they only affect the enzyme rather than the actual reaction. They do, however, reduce the rate of a reaction since enzymes increase the rate of a reaction; therefore, the answer is **A**.

Question 27: E

DNA bases are linked by hydrogen bonds. During transcription, DNA bases join to RNA bases, also with hydrogen bonds. Uracil will bind to adenosine with two hydrogen bonds, so the answer is **E**.

Question 28: E

During inspiration, the diaphragm is pulled down, thus increasing the volume of the thorax to reduce the pressure relative to the pressure outside the body. During systole, since the ventricles are contracting, the pressure in the ventricles is high and in the atria is low. The blood moves into the aorta, thus increasing the pressure in the aorta. The answer is the therefore **E**.

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Question 29: D

The pituitary produces LH and FSH, which are important for fertility in both men and women. The pituitary also produces ADH, which increases water reabsorption in the collecting duct, thus concentrating the urine. If production of these hormones is reduced, it could cause infertility or an increase in urine production, so the answer is **D**.

Question 30: D

Carbohydrate molecules are present throughout the cell. In the cell wall, cellulose is vital for maintaining structural integrity of the cell. The cell membrane has carbohydrates in the form of glycolipids and glycoproteins that are used for signalling. Carbohydrates exist in DNA in the nucleolus and also in the mitochondria, where they are used for respiration. The answer is therefore **D**.

Question 31: A

The passive movement of a molecule will be down its concentration gradient; therefore, the diffusion of molecule Q will be from cell Y to cell X. Movement in the opposite direction will be an active process, therefore **2** is correct but **1** is not. Molecules are also constantly moving in and out of cells, therefore **3** is also correct, so the answer is **A**.

Question 32: D

The cerebrum is the main area of the brain that controls memory formation. If this affected by an injury, a consequence is likely to be memory loss. **D** is therefore the correct answer.

Question 33: E

In an animal cell, the DNA is contained in the nucleus, but there is also circular DNA present in small amounts. Bacteria have 70S ribosomes and also have plasmids. Animal cells do not contain a cell wall. Thus from this information, the answer must be **E**.

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Question 34: E

There are three hydrogen bonds between cytosine and guanine, with two hydrogen bonds between adenosine and thymine. Thus, this section of DNA would have 31 available hydrogen bonds. There are also only 11 phosphodiester bonds between each nucleotide in the DNA strand. The subsequent tRNA molecules would be the same, as the DNA strand except the thymine molecules would be replaced by uracil, leaving 3 uracil bases.

Question 35: D

Cystic fibrosis is an autosomal recessive condition, and so if neither parent has the condition, they must be carriers of the mutated allele. Therefore, the chance of having a child without the condition is ¾. The chance of then having a boy is half of ¾, leaving 3/8, so the answer is **D**.

Question 36: D

During pyruvate decarboxylation, acetyl-CoA is produced from coenzyme A and pyruvate, with carbon dioxide and reduced NAD also being produced. Of these products, only reduced NAD is produced during glycolysis, therefore the answer is **D**.

Question 37: D

Haemoglobin has all four protein structures integrated in it. The primary structure is the amino acid sequence, and then there are bonds between non-adjacent amino acids that form the secondary structure. The protein folding makes up the tertiary structure and finally the four haem groups make up the quaternary structure. The answer is **D**.

Question 38: A

Active transport and facilitated diffusion are both needed to re-establish the necessary ion concentrations for a resting membrane potential. Respiration is needed to provide the cell with ATP for active transport; therefore, the answer is **A**.

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Question 39: A

In photosynthesis, carbon dioxide forms a 6-carbon unstable compound. Water is then broken up by light. The two hydrogen atoms are then used to reduce the unstable carbon compound to form two more stable 30carbon compounds. Therefore, the answer is **A**.

Question 40: A

Genes from animals, plants and prokaryotes can be used and inserted into genomes of other organisms to form a transgenic organism. Therefore **1**, **2** and **3** could all be possible combinations, so the answer is **A**.

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SECTION 3

Question 41: C

The most appropriate method for separating the specified components from the mixtures is correct for **B**, **C** and **D**. However, the mixture of water in a salt solution is not heterogeneous and the mixture of components of blood is not homogeneous. Therefore, the answer must be **C**.

Question 42: E

A normal oxygen atom will have the electron configuration $1s^2 2s^2 2p^4$, since it has 2 electrons in its inner shell and 6 in its outer shell. However, the oxygen in the question is an ion, with 2 more electrons, thus the configuration must be $1s^2 2s^2 2p^6$, so the answer must be **E**.

Question 43: A

Oxidation is the loss of electrons. Therefore, an oxidising agent will do the opposite and gain electrons. The chlorine in **A** reacts with potassium, resulting in the potassium losing electrons and the chlorine gaining electrons to form KCl. Therefore, the chlorine here is an oxidising agent, so the answer is **A**.

Question 44: B

With hydrochloric acid, we assume 100% dissociation into protons and chloride ions because the acid is so strong. In 10mL of the acid, there will be 0.01 moles of H^+ ions. $pH = -\log(H^+)$, thus the pH is 2, and the answer is **B**.

Question 45: D

As there are the same number of particles in one mole of a substance (Avogadro's constant), we just need to find the option with the greatest number of moles.

The two equations needed in this question are: Moles = Volume/22.4 and Moles = Mass/M_r.

A has 33.6/22.4 = 1.5 moles of gas.

B has 66/44 = 1.5 moles of gas.

C has 22.4/22.4 = 1 mole of gas.

D has 10/4 = 2.5 moles of gas (as helium is monatomic since it is a noble gas).

E has 64/32 = 2 moles of gas (since oxygen is diatomic).

Therefore, the answer is **D**.

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Question 46: E

The limiting reactant is the fluorine, since 3 moles of it will react with 1 mole of chlorine to give 2 moles of ClF_3. Therefore, 150cm^3 of fluorine will react with 50cm^3 chlorine to give 100cm^3 of ClF_3. There is still 50cm^3 of chlorine left from the reaction to give the final gaseous volume of 150cm^3, and so the answer is **E**.

Question 47: C

Methylcyclopentane is a methyl group attached to a pentane. Therefore, it consists of 6 carbon atoms and 12 hydrogen atoms. The only other molecule with the molecular formula C_6H_{12} is hex-2-ene, so the answer is **C**.

Question 48: A

In aqueous sodium chloride, there will clearly be molecules of NaCl and H_2O present. But there will also be ions of Na^+ and Cl^-. However, there will be no atoms of Na, Cl, H or O, since these will be present as ions. The answer is **A**.

Question 49: B

As the temperature is being reduced, the undissolved mass of potassium nitrate will increase and the concentration of potassium nitrate in the solution will decrease. However, the total mass of solvent (the potassium nitrate) will remain the same. Therefore, **B** is correct.

Question 50: C

From the formula XCl, we know that the grey solid must be in Group 1 or Group 7, and since the oxidation state is +1, it must be Group 7. We know that fluorine is a gas at room temperature and iodine is a grey solid at room temperature, therefore the answer is **C**.

Question 51: C

Silane is a silicon atom bonded to four hydrogen atoms. Therefore, there are 4 bonding pairs of electrons in this molecule. Silicon is in Group 4, therefore all four valence electrons are used in bonding pairs, so there are no lone pairs. The bond angle between each atom is 109.5°. The answer is **C**.

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Question 52: C

A is false because the number of electrons is different between the oxygen atom and ion. **B** is false because the oxygen ion also has two more electrons than the oxygen atom. The oxygen atom has 10 neutrons and therefore not half the amount of the silicon atom, which has 16, so **D** is false. **E** is false because the oxygen ion and sulphur atom do not have an equal number of protons, neutrons and electrons. Therefore, **C** is correct because both the ions do have 10 electrons, and the sodium ion has 12 neutrons compared to the 8 of the oxygen atom.

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SECTION 4

Question 53: A

To answer the question, draw out the map. The car ends up 4km further north and 3km further west than it started. Using Pythagoras' theorem, we know that the hypotenuse of the triangle created is of distance 5km, so the answer is **A**.

Question 54: E

For this question, we need to use the following equation:
Power = current^2 x resistance.
Thus, power = 100 x 5 = 500W, so the answer is **E**.

Question 55: D

To find the mean, we must add x, $\frac{x}{3}$ and x + 6.

This gives us $\frac{7x}{3}$ + 6

We must then divide this by the n, which is equal to 3, or multiply our solution by 1/3.

This gives $\frac{7x}{9}$ + 2 which can also be written as $\frac{7x + 18}{9}$

Question 56: C

The gradient of a straight line is given by rise over run. Between the first and second points, the line tracks back 3 and up 9. Therefore, the equation for the gradient of the line is 9/-3, or -3. The answer is therefore **C**.

Question 57: C

$\log_{10} 7 + \log_{10} 2$ can also be written as $\log_{10} (7 \times 2) = \log_{10} 14$.
$\log_{10} (14/3)$ can also be written as $\log_{10} 14 - \log_{10} 3$.
The answer is x + y – z, and therefore **C**.

Question 58: D

The upthrust on the cube is equal to the amount of oil displaced, which is equal to gravity x density of liquid x volume. The volume of a cube is a^3. Therefore, the upthrust = $\sigma a^3 g$ and the answer is **D**.

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Question 59: B

The gas receives the same amount of heat energy as it gives off to its surroundings. Therefore, the amount of energy is not being changed, just converted from heat energy to other forms. By definition, this change is referred to as isothermal, so the answer is **B**.

Question 60: E

The easiest way to solve this is to work out how many combinations of AABB there are with C in a fixed position. Taking C as the first letter, we know that there can be CAABB, CBBAA, CABAB, CBABA, CABBA and CBAAB. These 6 combinations will be the same for each of the 5 positions of C in the sequence; therefore, the answer is 30, or **E**.

END OF PAPER

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2018: SECTION 1

Question 1: E

Make a table to help work out the changes in seats between the parties:

	Alpha	Beta	Gamma	Total Change	Seats
Alpha		+15 – 31 = -16	+23 – 24 = -1	-17	103
Beta	+31 – 15 = 16		+41 – 10 = 31	+47	167
Gamma	+24 – 23 = 1	+10 – 41 = -31		-30	90

As Gamma has 90 seats, you can eliminate options that don't have a quarter in the pie chart, which leaves you options **C** and **E**. Beta has just under half the total seats, which means option **E** is correct

Question 2: A

Option **A** – The number of endangered species of fish and insects are both about 600 over 3 years.

Option **B** – The number of endangered mammal species rose from about 1100 in 2000, to nearly 1200 in 2001, before falling back to around 1100 in 2002, so option **B** is incorrect.

Option **C** – The direction of change has been swapped; amphibian species increase, whilst reptile species decrease.

Option **D** – In 2001, there were 1200 endangered species of birds, but less than 300 endangered species of reptile.

Option **E** – The number of endangered amphibian species increases by more than the number of endangered bird species.

Question 3: B

The conclusion from the study is that using certain cutlery can improve the taste of food. Therefore, if restaurants are trying to stand out for the quality of their food, then they should think about what cutlery they use.

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Question 4: D

B is wrong as, though watching television is said to raise blood pressure less than and burn fewer than playing video games, nothing is said about its effect on the mind. Options **A**, **C** and **E** are all true according to the passage, but they are facts that support the conclusion, not the conclusion itself. **D** is the correct answer, as it makes a direct comparison between watching television and playing video games, drawing from evidence used in the passage.

Question 5: E

Work through flavour by flavour.

For cheese flavoured crisps, the triplets will eat 3 packs a day, multiplied by 5 days in the week, multiplied by 4 weeks in the month: 3 x 5 x 4 = 60 packs.

You can reach 60 packs using multipacks of 36 and 24, so the total cost is:

£12.50 + £8.50 = £21.

Twins: 2 x 5 x 4 = 40

You can reach 40 packs with a multipack of 36 and 4 single packs, so the total cost is:

£12.50 + 4 x £0.50 = £14.50.

Oldest: 1 x 5 x 4 = 20.

You can reach 20 packs with multipacks of 12 and 6 and 2 single packs, so the total cost is:

£4.50 + £2.50 + 2 x £0.50 = £8.

Therefore, the cheapest monthly total cost is £21 + £14.50 + £8 = £43.50

The question is asking for the total saving, so you need to subtract £43.50 from the cost of buying just single packs. The family eat 120 packs a month, so 120 x £0.50 = £60.

Total saving is £60 - £43.50 = £16.50.

Question 6: A

There is no mention in the passage about how intelligent the animals are relative to each other or how complex their tasks are, so options **B** and **C** are incorrect. It states in the passage that there should be no reason why large animals need large brains, so option **E** is incorrect. Option **D** is an assumption. **A** is the correct conclusion.

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Question 7: E

The principle of the argument is that manufacturers should take responsibility because people are unable to make safe decisions. Only **E** does this, because it is the manufacturer limiting the top speed of cars. All the other options are trying to influence an individual's choices, not removing the choice from them entirely.

Question 8: A

Options **B**-**E** all weaken the argument. **D** supports the idea of vaccinating over hunting. **C** and **E** both suggest that culling is ineffective at killing badgers and on reducing bovine TB rates. **B** suggests bovine TB does not have a significant impact on the dairy industry. Only **A** supports culling over vaccination.

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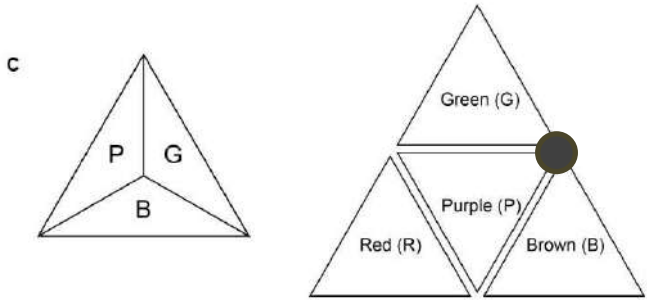
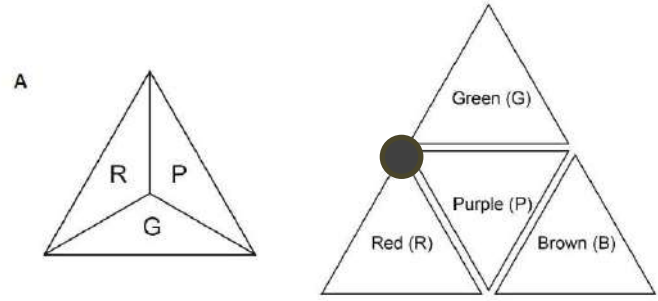
Question 9: D

Spatial reasoning questions like this are particularly tough. The trick is not to panic and work out what you know. We are looking from the top, at the corner where three sides meet. So for each option, choose the relevant corner on the net that would allow the three coloured sides to meet. For example, with option **C**, the colours visible are purple, green and blue, so the corner on the net will be this one:



If you imagine folding this round, G and B will meet, and you get option C. For option E, you might need to rotate the tetrahedron to confirm it to yourself. Option B is different because purple is on the bottom, but as you fold the shape you can see G forming the 'base' of the triangle you can see in option B, with R and B sharing an edge. The correct answer is option A, because when you fold around the corner where G, B and R meet you see that G and R are on the wrong side of P.



If this sort of visualisation is something that doesn't come naturally to you, for simple nets it might be worth drawing the net and trying to fold it up to see what options are or aren't possible.

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Question 10: C
The argument in the passage is structured that you want A (house in local area with three bedrooms and garage) and B (to spend €150,000), but to have A you must spend more on B (houses always cost more than €200,000). Option **C** most closely meets this - you want a powerful car (A) that is fuel efficient (B), but to have the car you are going to have to spend more on fuel.

Question 11: A
The passage assumes that the Icelandic diet is the cause of their health, but there might be reasons not mentioned, such as exercise. **B-E** talk about some the impracticalities of adopting the Icelandic diet, but don't dispute the argument that the diet provides positive benefits to one's health.

Question 12: E
The passage confuses correlation with cause, as there could be many reasons why more dentists is associated with lower obesity rates. For example, neighbourhoods with more dentists could be more affluent, which also affects obesity rates.

Question 13: A
Call Derek's house D, Barry's house B, the shop S and college C. It takes 45 minutes from Derek's house to college, 32 minutes from Barry's house to college, and 20 minutes from Derek's house to the shop. If it takes 45 minutes from D to C, and 32 minutes from B to C, then D to B must take 13 minutes. If D to B takes 13 minutes, and D to S takes 20 minutes, then B to S must take 7 minutes.

Question 14: B
Option **A** – Find the box corresponding to acrylic and polystyrene, which contains the letters D and H. Cyanoacrylate is E, so option **A** is incorrect.
Option **B** – Synthetic resin glue is E on the key, and on the table E can only glue plywood to plywood or balsa wood, so option **B i**s correct.
Option **C** – Balsa cement is letter C, so can be used to glue card to plywood and card, so option **C** is incorrect.
Option **D** – Card and acrylic can also be bonded by three types of glue, so **D** is incorrect.
Option **E** – find the box corresponding to polystyrene and card, which contains letter D. D is PVA glue, so option **E** is incorrect.

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Question 15: D
With these types of questions, it is best to set them up algebraically, as sometimes they can be quite complex.

Area of Massa's garden = 10 x 6 = 60m^2.
If we call cost per metre^2 x, then 60x = 12, so x = 0.2.

Perimeter of Massa's garden = 10 + 10 + 6 + 6 = 32.
If we call cost per metre y, then 32y = 8 so y = 0.25.

Cost of cutting Costa's garden = 15 x 9 x 0.2 = $27
Cost of trimming Costa's garden = (15 + 15 + 9 + 9) x 0.25 = $12
Total cost = $27 + $12 = $39

Question 16: C
The main argument of the passage is that we should ban deepwater drilling because the risk is too high, and when things go wrong, the people worst affected are the poor. Option **C** provides a counter argument, saying that not drilling for oil will also make poor people worse off. Option **A** supports the argument because it says oil companies knew the risks but disregarded them. Option **B** doesn't consider the damage done to the environment. Option **E** doesn't address the issue of whether deepwater drilling should be allowed now. Option **D** doesn't weaken the argument because it says that oil companies will change as a result of the accident and take the risks seriously.

Question 17: A
This is a question on proportions, so choose easy numbers to calculate, such as fats – saturates. The total saturated fat in 300g of oatcakes is 5.4g x 3 = 16.2g. Divide this by the amount of saturated fat in a single oatcake to get the total number of oatcakes. 16.2/0.7, which is the same as 162/7 = 23.

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Question 18: A

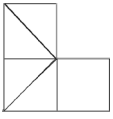
This question has lots of information to misdirect you. We want to work out how far the pigeon flies whilst the train is moving. A train traveling at 30mph will take 4 hours to go 120 miles. Therefore, the pigeon will be flying for 4 hours. The pigeon is flying at a constant speed of 40mph, so will have travelled a total of 160 miles.

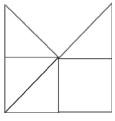
It's easy to get caught out by the question talking about where the train and pigeon meet and trying to find these interception points. Three things to always look out for in problems involving numbers. First, start with the question, so you know exactly what you're trying to find out and what information you need from the text. Second, if the numbers they give you seem neat, then you are very likely to use them. Finally, if you start getting decimal places and complex calculations, you've probably gone wrong somewhere. You don't have a calculator, so the questions are designed to be done quickly in your head.

Question 19: E

A

B

C 

D 

Only option **E** is not possible to make.

Question 20: A

The passage is arguing that we should be careful about using computer-based learning because of the risk of internet addiction and the negative impact this has on educational achievement. However, for this to be true, the passage must assume that all computer-based learning involves the internet.

Question 21: A

The *Almagest* was written by Ptolemy in the 2nd century and argued for a geocentric model of the universe.

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Question 22: B

The answer is **B** – the most popular national newspapers in Denmark are the B.T. and the Politken.

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SECTION 2

Question 23: B

Exercise causes the production of lactic acid, which will decrease the pH in muscle and blood. During exercise, blood flow is redirected to the muscle, where the oxygen demand is greatest.

Question 24: B

The active site of a protein is affected by all the levels of structure present. As there are two chains, this gives the protein a quaternary structure.

Question 25: E

Statement **1** – Incorrect. Independent assortment occurs before the zygote has formed.
Statement **2** – Incorrect. Crossing over occurs during meiosis when the sperm and oocyte are formed, not during fertilisation.
Statement **3** – Correct. The random alignment of homologous chromosomes during metaphase I of meiosis causes independent assortment.

Question 26: A

Separation of the chromosomes occurs during anaphase. In meiosis I, pairs of chromosomes line up and are pulled part, whereas in mitosis the sister chromatids are pulled apart.

Question 27: D

COV (crossover value) is a measure of how likely two genes on the same chromosome are to crossover. The closer the two genes are to each other on the chromosome, the smaller the crossover value. R and Q have the highest COV, so they must be the furthest genes apart. This means you can eliminate all the options apart from **A**.

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Question 28: B

A. Incorrect. Semi-lunar valves are between the ventricles and arteries, so when the pressure in the ventricles is higher during contraction, the valves will be open.
B. Correct. When the ventricles are contracting, the atria are relaxed so can fill.
C. Incorrect. For the ventricles to be contracting, the wave of electrical activity will have already passed the AV node.
D. Incorrect. When pressure in the ventricles is highest, the heart is in ventricular systole
E. Incorrect. The AV valves between the atria and the ventricles will be closed to prevent backflow of blood into the atria.

Question 29: B

Reverse transcriptase is an enzyme that produces complementary DNA (cDNA) from an RNA template.

Statement **1** could be correct because if the inhibitor molecules are similar to nucleotides, they could competitively inhibit the enzyme.

Statement **2** could be correct because DNA cannot form without phosphodiester bonds.

Statement **3** is correct because if reverse transcriptase is inhibited, fewer viral proteins will be synthesised, so fewer new virus particles will be produced.

Question 30: E

A molecule of DNA with 100 nucleotides in total will be 50 nucleotides in length (50 nucleotides on each strand). Phosphodiester bonds are found between bases on the same strand, so there will be 49 bonds on each strand, giving a total of 98. If 38% of the nucleotides contain thymine, then there will be 38 T bases, 38 A bases (A and T pair), and 12 C bases and 12 G bases (C and G pair). There are two hydrogen bonds between A&T and three hydrogen bonds between C&G. Therefore, the total number of hydrogen bonds will be $38 \times 2 + 12 \times 3 = 112$

Question 31: A

Statement **1** – Incorrect. In order to be male, he must have inherited the Y chromosome from his father.

Statement **2** – Correct. The allele is dominant, so no one can be a carrier.

Statement **3** – Incorrect. The allele is dominant, so only one parent needs to have it

Statement **4** – Correct. He will always pass on the dominant X allele.

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Question 32: D

If you realise that structures are unlikely to have two types of epithelium, then all you need to do is identify which of the structures contains cartilage. The trachea has cartilage rings to prevent it collapsing, which would cause asphyxiation, so **D** is correct.

Question 33: C

Statement **1** – DNA is extremely stable and does not break down, so this is incorrect.
Statement **2** – This is correct.
Statement **3** – This is incorrect, as the allele for CF is recessive.

Question 34: D

Statement **1** – The gall bladder stores bile but doesn't make it.
Statement **2** – The pancreas secretes bicarbonate to neutralise stomach acid in the duodenum.
Statement **3** – The stomach produces acid, which lowers the pH in the digestive system

Question 35: B

The organism must be eukaryotic, as it contains organelles, so we can rule out **E**. Grana are found in chloroplasts, so we know the organism must be capable of photosynthesis. This means **C** is incorrect, as oxygen is released in photosynthesis. Some cells are releasing CO_2 all the time, so those cells must be respiring and not photosynthesising, as otherwise the CO_2 could be used in photosynthesis. This rules out **A** and **D**, leaving **B** to be the correct answer.

Question 36: E

Ribosomes, antibodies and cilia are all proteins, so will contain peptide bonds. Cholesterol is a lipid, so will not.

Question 37: A

Statement **1** – Correct. In response to infection, B lymphocytes undergo mitosis to increase the strength of the immune response.
Statement **2** – Correct. B cells produce antibodies, which are proteins
Statement **3** – Incorrect. B cells are not phagocytes

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Question 38: A

All three changes could cause an increase in the growth and reproduction rate of species V. The first two could give the optimum conditions for species V or kill off W, allowing V to outcompete W and use the resources that W would otherwise use. If V is resistant to the antibiotic, but W is not, then V would outcompete W again.

Question 39: A

tRNA and DNA are both complementary to mRNA, so the anticodons 1, 2, 3 and 4 will form the DNA strand, but because it is now DNA U will be replaced by T.

Question 40: A

Statement **1** – Correct. Neurotransmitters are released into the synapse by exocytosis.

Statement **2** – Correct. Cells contain all the genes, but most are switched off and not expressed.

Statement **3** – Correct. Neurons contain mitochondria, which contain circular DNA.

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SECTION 3

Question 41: A

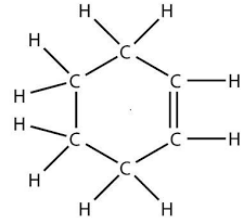
Cl_2O – oxygen always has oxidation state of -2, so Cl must have a state of +1 to make the compound neutral.
KCl – K is always +1, so Cl must be -1.
KClO – K is +1, O is -2, so Cl is +1.
$KClO_3$ – K is +1, O is -6 in total, so Cl must be +5.
$KClO_4$ – K is +1, O is -8 in total, so Cl must be +7.
Cl_2O_7 – total O charge is -14, so Cl must be +7.

Question 42: B

For something to be soluble, the solute must form stronger bonds with the solvent than between solute and solute and solvent and solvent.
In options **A** and **D**, the ionic bonds of the solute are stronger than the London forces that would be formed with the organic solvent, so neither would be soluble at room temperature and pressure. In options **C** and **E**, the hydrogen bonds between water molecules are stronger than the London forces that could be formed with the solutes, so neither would be soluble. Molecules of bromine and cyclohexane are held together by London forces, so bromine would be soluble in cyclohexane.

Question 43: A

Cyclohexane has the molecular formula C_6H_{12}, then take away two hydrogens because of the double bond present in cyclohexene to get C_6H_{10}.



Question 44: C

Na^+ and O^{2-} both have 10 electrons, so **C** is correct.

Question 45: B

Atom W has two full shells of electrons, which means it has the highest first ionisation energy.

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Question 46: A

There are 6 carbons in a row, so can eliminate options **B**, **C** & **D**. Under IUPAC convention, you start the numbering at the end with the most reactive group. This means carbon 1 is at the end closest to the alcohol group, so the methyl groups are attached to carbon 2 and carbon 4, so **A** is correct.

Question 47: E

Whether a molecule is polar or nonpolar depends on its geometry. If one end of the molecule has a positive charge, while the other end has a negative charge, then the molecule is polar. If charge is evenly distributed around a central atom, then the molecule is nonpolar. BF_3 and CO_2 both have an even distribution of charge so are polar, whereas CH_2Cl is nonpolar because it has an imbalance of charge because of the lone pairs of electrons around the chlorine atom. Therefore, we can eliminate rows **1**, **2** and **3**. NH_3 is polar, because it has a lone pair of electrons. However, because of this lone pair, the hydrogen atoms are repelled, and its shape is trigonal pyramidal. This leaves PCl_5, which has an equal distribution of charge around the central P. 5 covalent bonds means it forms a trigonal bipyramidal shape.

Question 48: D

Use the equation pV = nRT, where p is pressure, V is volume, n is moles, R is the gas constant and T is temperature. V and n are fixed at 1, and R = 8.3.
Substituting in, you get p = 8.3 x 283 (10◦C in Kelvin).
We want to know the temperature required to double the pressure, so 2p = 8.3T.
Substitute in p and we get 2 x 8. 3 x 283 = 8.3T.
Cancel out 8.3 from both sides and you get T = 2 x 283.
We need to subtract 273 to convert from Kelvin back to ◦C, which gives us a final answer of 293◦C.

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Question 49: D

A. Incorrect. Water is donating a proton, so it is acting as a Brønsted-Lowry acid.
B. Incorrect. CH_3O^- can donate a pair of nonbonding electrons, making it a Lewis base.
C. Incorrect. The presence of hydroxide ions would make the solution alkali, so it would have a pH above 7.
D. Correct. A conjugate acid is the compound formed when a proton is added to a base. In this case, CH_3O^- has accepted a proton, making CH_3OH its conjugate acid.
E. Incorrect. Water has lost a proton, making OH^- its conjugate base.

Question 50: B

The kinetic energy of an ideal gas is proportional to temperature multiplied by the constant k. As temperature is constant in this scenario, we must be changing the constant in some way. Boyle's law states that PV = k. Therefore, in statements **2** and **3**, we are increasing either P or V whilst keeping the other value the same, therefore the k will increase and so will the kinetic energy. For statement **1**, we are using Avogadro's law, which states that V/n = k. By increasing the number of moles of gas but keeping the pressure and volume constant, k will decrease and so will the kinetic energy, making statement **1** incorrect.

Question 51: E

Statement **1** – Correct. At a higher pressure, there are more collisions.
Statement **2** – Incorrect. At a higher pressure, the position of equilibrium is shifted to increase the yield of NH_3.
Statement **3** – Incorrect. Pressure does not affect the energy of molecules.

Question 52: A

Statement **1** – Correct. Group 1 elements always form +1 ions, so the oxidation state of hydrogen in a hydride must be -1.
Statement **2** – Correct. Group 1 elements can act as reducing agents.
Statement **3** – Correct. In a liquid state, their outer electrons are delocalised.

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SECTION 4

Question 53: E

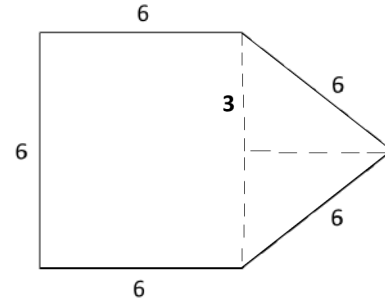
$x + 4 = x(x + 1)$

$x + 4 = x^2 + x$

$0 = x^2 - 4$ This is a difference of two squares, so $0 = (x + 2)(x - 2)$

x is either 2 or -2, and the sum of them is 0.

Question 54: E



Draw out the shape. For a pentagon to have two parallel sides, it must be a square with a triangle attached. We're told one interior angle is 60°, and all the sides are 6 cm, so we know the triangle is equilateral. The area of the square is easy to calculate, but for the triangle we need the height.

Use Pythagoras' theorem: $6^2 - 3^2 = c^2$

$36 - 9 = 27$ so $c = \sqrt{27}$.

The area of the triangle is ½ x base x height, so $3\sqrt{27}$, or $9\sqrt{3}$.

The total area of the pentagon is $36 + 9\sqrt{3}$, which you factorise by taking out the 9 to get $9(4 + \sqrt{3})$.

Question 55: B

If there is a constant resultant force, then there will be constant acceleration. If there is constant acceleration, then velocity will increase.

Question 56: E

The equation for the gradient of a perpendicular line is -1/m (where m is the gradient of the old line). Therefore, $y = -1/2x + c$. Rearrange this into the form of the answers, so $2y + x = c$.

We know the line passes through (4, 3), so substitute these values in.

$2(3) + 4 = c$, so $c = 10$ and the answer is **A**.

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Question 57: E

A picometre is 1×10^{-12}m, a nanometre is 1×10^{-9}m, a micrometre is 1×10^{-6}, so in effect they are each 1000 times larger than the next. Convert picometres and micrometres into nanometres.

1650 pm = 1.65 nm and 0.0036 μm = 3.6 nm. Therefore the order is: 1.5 nm, 1650 pm, 0.0036 μm.

Question 58: E

The resistance of a wire is $R = \rho L/A$, where ρ is resistivity, L is length and A is cross-sectional area.

Substitute in the values and we get:

$$R = \frac{2 \times 1 \times 10^{-6}}{\pi \left(1 \times 10^{-3}\right)^2} = \frac{2 \times 10^{-6}}{\pi \times 10^{-6}} = \frac{2.0}{\pi}\ \Omega$$

Question 59: D

All gases at a given temperature have the same average kinetic energy, so **3** and **4** are incorrect. Nitrogen is smaller than oxygen, so will have a faster velocity, making **2** correct and **1** incorrect.

Question 60: D

Expanding out (3×10^3) gives you $3^3 \times 10^{3\times3}$, which is 9×10^9.

$9 \times 10^9 \times 2 \times 10^{-5} = 18 \times 10^4$, or 1.8×10^5

END OF PAPER

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2019: SECTION 1

Question 1: B

60% of £21 000 is £12 600. Central stalls cost £28, so to make £12600 at £28 per seat, (12600/28) 450 seats must have been occupied. Since each row contains 30 seats, there must have only been 15 (450/30) rows making up the central stalls.

Question 2: D

This passage argues that fun is irrelevant to education; the only thing that matters is whether the student leaves the lesson more educated than when they arrived. However, the passage treats having fun and learning as mutually exclusive – it does not consider the idea that if pupils enjoy a lesson, they will be more engaged and so will learn more. As a result, **D** is the answer.

Question 3: D

Total lawn area can be calculated efficiently if one perceives the shape as a 4 x 6 rectangle with a 2 x 1 rectangle taken out.

$(4 \times 6) - 2 = 22m^2$.

The amount of seed required is $22 \times 50 = 1100g$ or 1.1kg.

So, a 1kg packet and a 100g packet are needed.

£14 + £2 = £16.

Question 4: C

The argument of this passage is that since we are becoming increasingly eco-friendly as a society, we are more likely to choose wooden floor instead of carpets as the former is better for the environment. Why is floor better? Because apparently carpets are plastic-based, and its underlay is made from petrochemicals. This argument is based on the assumption that laminate and wood flooring is not plastic-based and does not have an underlay made from petrochemicals. If this is wrong, then the argument is flawed.

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Question 5: C

Tia would have 8 points without playing the joker. To get 14, she must have used a joker on a winning event to get an additional 6 points. Jessica would have 13 without the joker, meaning she must have also played the joker on a winning event to get to 19. Carolina would have 14 points without winning a 'joker' event, meaning she didn't win a 'joker' event. Kelly didn't win any event, so even if she did play her joker, it wouldn't satisfy the question's criteria of 'won the event in which they had elected to play the joker'. Finally, Helena would only have 7 points without winning a joker event, so she must have used the joker on a winning event to get to 13. In total, 3 of the girls satisfy the question's criteria.

Question 6: D

In the passage it was mentioned that *some,* not all, of the over-65s who took part in the training received benefits spanning at least 5 years. Nowhere did it mention whether older people would perform mentally challenging tasks unless forced to, and the same applies to the amount of housework done as people get older. The rate of mental decline was mentioned, but no opinion was given. Therefore, the conclusion is simply "Keeping the mind active delays the onset of dementia" – anything beyond this would be an extrapolation.

Question 7: D

Nothing is mentioned about **B**. Oxygen deficiency is under the umbrella term "physiological cause", therefore **E** and **C** point in the same direction. Both are false because the passage states that not all resuscitated cardiac patients have NDEs, so they can't have purely physiological causes. **A** is the supporting statement which allows us to conclude that **D** is the answer.

Question 8: D

This box has 6 faces:

- 2 are 40cm x 30cm
- 2 are 20cm x 40cm
- 2 are 20cm x 30cm

For the 40cm x 30cm face, the string used is 40 + 30 = 70cm.

For the other faces, the same rule applies. 20 + 40 = 60cm and 20 + 30 = 50cm.

So, the total length of string used for the faces is 2 x (70 + 60 + 50) = 360cm.

Add the 20cm of string needed for the knot and the answer is 380cm or 3.8m.

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Question 9: D
First, recognise that you can only use one of **A** and **D**. **B** will slot into the 2 x 3 space, **C** will lay horizontally underneath, and **E** will fit vertically on one side of **A** or **D**. Looking at **B**, you can see that it would not fit into **D**, as its black stripes would be underneath **D**'s white and vice versa. Therefore, **D** is not needed.

Question 10: E
The main argument in this passage is that the recent drop in the catch of marlin is the result of the long-term fish population cycle related to migration. This conclusion came about as a result of the research into the fishing catch of marlin over the last six centuries. In order for this conclusion to be valid, the records have to be accurate. And since there was no mention of whether the records are indeed accurate, it was an underlying assumption.

Question 11: B
20th Century author Harper Lee wrote and published the American classic *To kill a Mockingbird* in 1960, for which she won the Pulitzer Prize in the subsequent year.

Question 12: B
Stated objectives of the United Nations include maintaining international peace and security, protecting human rights, delivering humanitarian aid, upholding international law and promoting sustainable development. Encouraging trade is not a stated purpose of the UN.

Question 13: A
Born in Lucca, Italy, Puccini is often known as the greatest composer of Italian opera after Verdi. He composed Madame Butterfly in 1904. His other major works include Turandot, Tosca and La Bohème.

Question 14: E
To this day, Swedish currency is still the Krona (SEK). As of October 2019, each Euro is worth around 10 Kronas.

Question 15: A
A Midsummer Night's Dream was set in Ancient Athens, Greece.

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Question 16: C
The October Revolution happened in 1917 and the fall of the Western Roman Empire happened in the 5th century. The Taiping Rebellion took place between 1850-1864. The Taj Mahal was built around years 1632-53. Charlemagne was crowned Emperor of the Romans on Christmas Day of year 800.

Question 17: D
Polish scientist Marie Curie was awarded a Nobel Prize in Physics in 1903 and a Nobel Prize in Chemistry in 1911, thus making her the first woman to win the Nobel Prize, as well as the only woman to ever win the prize twice.

Question 18: E
The prisoner's dilemma is part of game theory, which is the study of how rational decision-makers strategically interact with one another. The classic version of the prisoner's dilemma is about how the prisoners' individual optimal strategy is always to betray their partner-in-crime under certain circumstances.

Question 19: B
Hinduism is unlike other major religions in that it has no founder but is more likened to a fusion of various beliefs. It began in what is now India around 5000 years ago.

Question 20: C
The Italian Constituent Assembly was a parliamentary chamber in Italy between 1946 and 1948. The purpose behind this chamber was to write a new constitution for the Italian Republic, which replaced the Kingdom of Italy after the civil war. The text was enacted on 22nd December 1947.

Question 21: C
Rumi was a Persian poet of the 13th century. His works are mostly written in Persian, of which, Masnavi is often considered one of the greatest poems of the Persian language.

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Question 22: E

The typical separation of powers divides the state government into a legislature, an executive and a judiciary power (also known as the *trias politica)*. The intention behind this separation is to prevent the concentration of unbalanced power leading to a potential autocracy.

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SECTION 2

Question 23: A

The object in question is 30mm in length after a 30000x magnification, meaning that its actual length is 30mm / 30000 = 1um (micron). This is the standard size of a prokaryotic cell such as a bacterium.

Question 24: A

B-Lymphocytes are formed and matured in the bone, starting as bone marrow stem cells. They contain genes for coding for antibodies. T cells, not B cells, are processed in the thymus.

Question 25: C

There are 2 individuals without the condition, therefore they must be the only homozygous recessive individuals (i.e.without a single FH allele). This narrows our answer to row **1** or **3**. The number of heterozygous individuals could be 2 or 3 depending on whether the affected mother was homozygous or heterozygous FH. There definitely can't be 3 homozygous dominant individuals, because the 2 affected children received a healthy allele from their unaffected father. So, only row **3** is a possible correct answer (assuming the mother is heterozygous).

Question 26: D

Anaphase is the phase in mitosis where the sister chromatids of the centrally aligned chromosomes are pulled apart by spindle fibres towards opposite poles of the cell.

Question 27: C

Parasympathetic neurons are part of the autonomic motor pathway, meaning that they travel in the ventral root. Another feature of parasympathetic neurons is that they synapse very close to the organ.

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Question 28: B
Viral envelopes derive from host cell membranes, so contain phospholipids (fatty acids), proteins and also viral glycoproteins. Inside these envelopes are capsids. Capsids are made of proteins (amino acids) and it encloses the genetic materials of the virus. Row **1** is wrong because the envelope does not contain glycogen. Row **2** is incorrect because capsids don't have glycogen. Row **3** is incorrect because genetic material doesn't contain amino acids. Row **5** is incorrect because capsids don't have phosphodiester bonds.

Question 29: D
All somatic cells, including hair follicle cells, have the same genes and alleles. The phenomenon of spotted fur coat is achieved by transcription factors. Each white hair follicle cells could have dominant alleles as well, as long as the dominant allele is not transcribed.

Question 30: E
Cartilage and endothelium are collections of similar cells; therefore, they can be classified as tissues. Skin on the other hand is comprised of different tissues such as epithelium, nervous tissue and adipose tissue, therefore it is an organ.

Question 31: A
P: ATTCCGGGATTCCCT
Q: ATTCCGGATTGCACT

The underlined sections are the sections of the two codes that differ.

Substitution could be a possible cause for the change (GATTCCCT could have just substituted to ATTGCACT, 8 bases for 8 bases). Addition could have also worked. Since P and Q are only sections, we're not aware of the code that comes after P and Q, so for all we know, ATTGCACT may have been inserted just in front of the GATTCCCT of P and displaced it. By a similar logic, we can also assume deletion to be a possibility. Perhaps in the original code, ATTGCACT immediately follows GATTCCCT, so that after GATTCCCT was deleted, ATTGCACT slid back and took its place.

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Question 32: E

Only ethanol and dilute HCl have any effect on cell permeability. Ethanol is often used as an organic solvent because of its ability to dissolve other organic substances, such as phospholipids. Once the phospholipid membrane dissolves, pigment can leave the cell, staining the fluid red. HCl denatures proteins, contributing to the release of pigments in several ways, such as the disruption of membrane protein integrity which opens pores in the membrane, letting pigment out.

Question 33: A

Rows **1**, **2** and **4** are correct. Row **3** is incorrect because each glycerol can be chemically described as propane-1,2,3-triol, so it has more than 2 hydroxyl groups.

Question 34: D

Myosin length doesn't change during contraction, so the length of the A-band remains constant. However, there is more overlap between actin and myosin, so the length of the I-band reduces and so does the length of the H-band.

Question 35: E

Urea present in the blood. From there, urea concentration will only increase as tubular fluid passes through the different parts of the kidney. After all, urea concentration and removal is the function of the kidney.

Question 36: E

Plants photosynthesise only when there is light, but they are respiring all the time, irrespective of the time or light presence. CO_2 is produced during respiration, and when light is available, this CO_2 will be used for photosynthesis.

Question 37: C

Restriction enzymes are important in gene modification because they break the strongest link in the DNA, which is the phosphodiester bond which connects adjacent nucleotides, thereby forming 'sticky ends' in the process. Ligase does the opposite by joining two sticky ends together.

Question 38: E

1 (original number of cell) x $2^{10\ (\text{number of divisions})}$ = 1024

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Question 39: C

Most CO_2 is transported in the blood in the form of bicarbonate. Increasing partial pressure of oxygen will not make haemoglobin release its oxygen; it will load the haemoglobin with more oxygen. Comparing oxygen binding curves for haemoglobin and myoglobin shows that myoglobin is more saturated than haemoglobins at any partial pressures. This makes sense because it's more important for oxygen to be in the cells than in the blood. Active muscles respiring aerobically won't produce significant amounts of lactic acid. So, one would not detect an elevated level of lactic acid in the blood leaving the muscle. A high CO_2 concentration does indeed reduce haemoglobin's affinity for oxygen. This is a useful mechanism allowing haemoglobin to deposit oxygen more efficiently in areas where the rate of respiration is high.

Question 40: E

All of the above processes involve ions. Contraction of muscle involves calcium ions. Transmission of a nerve impulse involves calcium ions and sodium ions. Photolysis (light-dependent step of photosynthesis) involves hydrogen ions. Oxidative phosphorylation also involves hydrogen ions.

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SECTION 3

Question 41: C

There is no chemical reaction, and the physical energy of powdered sugar being dropped on the ice is hardly enough to cause all of the ice to melt, thus ruling out the first statement. Sugar mixing with ice helps to disturb the lattice structure of the ice, thus reducing the melting temperature, so that it is lower than -1°C.

Question 42: A

In **1**, Lithium is oxidised, but no species is reduced. In **2**, no species is oxidised or reduced. In **3**, Nitrogen is both oxidised and reduced, therefore **3** is the only equation which represents a redox reaction.

Question 43: C

$K_c = ([C]^2 [D]) / ([A] [B]^2) = 10$

Question 44: E

There are 4 grams of oxygen, 3 g of carbon and 1g of hydrogen.
So, first we work out the empirical formula.
The ratio of C : O : H = 3/12 : 4/16 : 1 = 1 : 1 : 4
So, the empirical formula is CH_4O.
Out of the 5 options, only CH_4O is a multiple of our empirical formula.

Question 45: E

Iodine exerts less electrostatic forces of attraction on its outer shell electrons compared to bromine, due to increased electron shielding as well as atomic radius. This means that iodine's outer shell electrons are held less tightly and can more easily form temporary dipoles (dispersion forces). HBr will actually have stronger permanent dipole-permanent dipole forces than HI due to bromine having a higher electronegativity than iodine.

Question 46: E

The fact that Z forms a compound with a single atom of oxygen means that it forms 2+ ions. Transition metals can form 2+ ions, but they generally do not react with water at room temperature. Therefore, Z is a Group II element.

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Question 47: C
Neutrons are neutral in charge and therefore cannot affect the charge of ions. A positive ion has an overall positive charge; therefore, it must have more positively charged protons than negatively charged electrons (given that protons and electrons have equal magnitudes in charge contribution).

Question 48: D
CO_2 has no permanent dipole moment because it is symmetrical in shape. H_2O and NH_3 are not symmetrical due to the presence of the non-bonding pairs of electrons on their oxygen and nitrogen atoms, respectively. Since both oxygen and nitrogen are more electronegative than hydrogen, and the molecule is not symmetrical, there is an overall permanent dipole moment.

Question 49: D
NaOH is a strong alkali, so the indicator would show violet to start. As acid is gradually added, the pH will gradually approach neutral, so colour will turn from violet to blue and then to green as the pH reaches ~7. Remember that violet shows a stronger alkali than blue!

Question 50: B
The mass of tritium is mass of hydrogen + 2 (one for each extra neutron) = 3. So, the average mass of a balanced mix of tritium and hydrogen is (1 + 3) / 2 = 2.

Question 51: D
All 3 configurations show 2 chemicals with the same molecular formula. However, only **1** and **3** show 2 chemicals with different structural formulae. Both chemicals shown in **2** are 2-methylpentane.

Question 52: E
500mL of 3mol/L concentration means there are 1.5 mol of SO_2 in the solution. Since SO_2 has a molecular weight of (16 + 16 + 32 = 64), 1.5 x 64 = 96g.

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SECTION 4

Question 53: B

Acceleration = 4, time = 5, initial velocity = 0.
So, final velocity (or maximum speed) = 4 x 5 + 0 = 20 m/s.
Distance travelled = 20 s x 20 m/s = 400 m

Question 54: D

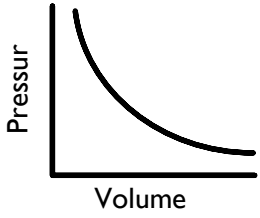
The lightest is 1.8kg, the heaviest is 1.8 + 0.7 = 2.5 kg.
So, the middle baby must have a mass of:
3 x mean = 3 x 2.1 = 6.3
6.3 – (1.8 + 2.5) = 2.

Question 55: E

Mass of fluid displaced = 1.2 x 200 = 240 g
Upthrust = 0.24kg x 10 N/kg = 2.4 N

Question 56: B

Recall ideal gas laws: pressure is inversely proportional to volume given a constant temperature.
P x V = K (K is a constant).
P = K/V.
Imagine the curve of y = 1/x – it'll look similar to that.



Question 57: D

First let's break down these numbers into their prime factors. Then, find the factors that are in common between all three numbers.
360 = 2 x 2 x 2 x 3 x 3 x 5
500 = 2 x 2 x 5 x 5 x 5
700 = 2 x 2 x 5 x 5 x 7
In this case, these are 2, 2, and 5.

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Question 58: E

$$\frac{3}{x} + \frac{2}{x-2} = 1$$

$$\frac{3(x-2) + 2x}{x(x-2)} = 1$$

$3x - 6 + 2x = x^2 - 2x$
$x^2 - 7x + 6 = 0$
$(x - 6)(x - 1) = 0$
$x = 6$ or $x = 1$
$6 + 1 = 7$

Question 59: C

Since 8 can be written as 2^3 and 4 as 2^2, $\frac{8^{2n} \times 4^n}{2^n}$ can be written as $\frac{(2^3)^{2n} \times (2^2)^n}{2^n}$, which can be simplified to $2^{6n} \times 2^{2n} \times 2^{-n} = 2^{7n}$

Question 60: E

Use the inverse square law: $\text{Force} = k\frac{\text{Charge of P} \times \text{Charge of Q}}{\text{Distance}^2}$

$$F = k\frac{1.50 \times 10^{-7} \times 1.50 \times 10^{-7}}{0.1^2}$$

$$k = \frac{F}{2.25 \times 10^{-12}}$$

$$F = \frac{F}{2.25 \times 10^{-12}} \times \frac{4.50 \times 10^{-7} \times 6.00 \times 10^{-7}}{0.20^2} = \frac{6.75 \times 10^{-12} \times F}{2.25 \times 10^{-12}} = 3F$$

END OF PAPER

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A NOTE ON THE 2020 IMAT PAPER

The 2020 paper is the most recent one to be released. However, only a modified version of the paper has been made available, rather than the actual paper sat by students. Though the questions are all the same, you may quickly identify a pattern in the answers. If you do, it is recommended to still do this paper properly, working through every question so you fully understand the reasoning or the method behind the correct answer. If you get an answer wrong, try and work out what mistake you made so you don't repeat it. You may get full marks by spotting the pattern, but that won't help you in the real exam.

2020: SECTION 1

Question 1: A

The passage is about the negative effects of positivity. As such, **B** and **E** must be wrong. Because the passage concerns positivity, rather than negativity, **D** is also incorrect. **C** is true, but it is a statement that backs up **A**, which is the main conclusion.

Question 2: A

First, think about the specific issue the paragraph is talking about. The passage discusses the legal issues surrounding car crashes, so **B**, **C** and **E** are irrelevant. This leaves us with **A** and **D**. Though the passage states that it is difficulty to assign responsibility in the event of a crash, it does not say it is impossible, so **A** must be the answer.

Question 3: A

The passage starts by explaining Mondrian's reason for moving to London, then proceeds to apply the same logic to all artists. As a result, the assumption in the argument is that all artists think the same way as Mondrian, and so **A** is the answer.

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Question 4: A

For this question, the answer will be the option that best supports the argument that prisoners should not be able to receive books from family or friends. **B** is incorrect because even if the library has a limited selection, prisoners can still buy books themselves. **C** is irrelevant as there are issues other than the availability of books that contribute to low levels of literacy. **D** is also not relevant as prisoners still have the option of buying books regardless of their other purchases. **E** is wrong as detective stories could still be available to buy or in the libraries. **A**, however, is a good argument as drugs could harm the prisoners, so prohibiting parcels containing books would reduce the number of drugs entering the prison, while not preventing access to books.

Question 5: A

These questions can be complicated, but there is often a simple answer. The statement's logic is that people go somewhere because of a love of something associated with that place, so people that go somewhere else must hate it. **A** closely mirrors that, only love and hate is reversed. None of the other options are concerned with liking something, so cannot be correct.

Question 6: A

The simplest method for this question is to calculate the price for 1 kg of powder:

A: 2 kg = £2.40, so 1 kg = £1.20
B: 1 kg = £2.50
C: 2 kg = £4.95, so 1 kg = £2.48
D: 1 kg = £1.30
E: 1 kg = £1.25

We can see that **A** has the lowest price per kilo, so **A** is correct.

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Question 7: A

The best way to do this is to start with a large number of sweets – I used 100 to make it easier to calculate the percentages.

If 36% of 100 sweets have been eaten, 64 are left.

25% of the 64 sweets = 0.25 × 64 = 16

64 - 16 = 48 sweets left

16 sweets are eaten each day for two days, so 32 sweets are eaten

48 - 32 = 16 sweets are left.

Question 8: A

For a family to have three or more siblings, identify the children in the table who have two or more siblings, as the child in the table counts as one sibling. The relevant children are:

1. Callum
2. Leroy
3. Gemma
4. Paul
5. Rajiv
6. Emily
7. Fatima
8. Candice
9. Marvin
10. Aruna
11. Phoebe

There are 11 families in total, so the answer is **A**.

Question 9: A

Autogas: $10{,}000 + 30 \times \frac{20{,}000}{200} = \$13{,}000$

Diesel: $12{,}000 + 50 \times \frac{20{,}000}{500} = \$14{,}000$

Petrol: $10{,}000 + 50 \times \frac{20{,}000}{400} = \$12{,}500$

Hydrogen: $9{,}500 + 50 \times \frac{20{,}000}{200} = \$14{,}500$

Electric: $12{,}500 + 5 \times \frac{20\,000}{200} = \$13{,}000$

Petrol is the is the cheapest, so **A** is the answer.

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Question 10: A

This question difficult, but there is a quick and easy way of approaching it if you take a moment to think. After the first fold, the size of the grid will go from 4x4 to 2x4 (width of two, height of 4). The dot will be drawn in the middle of this rectangle. This means that, in the correct answer, there will be only one dot in the centre of one half of the paper. Only **A** and **E** have one dot on one side, but it is not centred in **E**, so **A** must be the correct answer.

To check, you can apply the same logic for a second time to **A**. When folded again, the grid will go to a size of 2x2, and the dot will be drawn in the centre again. You can see the dot in the upper-left corner of **A** is in the centre of a 2x2 square. If you're still not sure, try drawing it on a piece of paper. Thankfully, there only tends to be one spatial reasoning question on the IMAT, so they don't need to be a high priority when preparing.

Question 11: A

The answer is **A**. The Romance languages are derived from Latin and are common in western Europe, with the exception of Romania which is in the southeast. Bulgarian is a Slavic language, and is written in a Cyrillic alphabet, rather than a Latin one.

Question 12: A

Charles Dickens never won a Nobel prize for literature, so the answer is **A**.

Question 13: A

Amacord is a semi-autobiographical film, telling the story of a boy growing up in 1930s Italy when it was led by Mussolini, a fascist. Federico Fellini directed it.

Question 14: A

Beyond Good and Evil was written by the Friedrich Nietzsche, not Primo Levi.

Question 15: A

The normal distribution is also known as the Gaussian distribution, so it isn't too much of a stretch to infer that **A** is correct.

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Question 16: A
On 12th April 1961, Yuri Gagarin orbited Earth. Neil Armstrong and Buzz Aldrin were the first and second men on the moon respectively. Valentina Tereshkova was the first woman to go to space. John Glenn was the first American, but not the first human, to orbit the earth.

Question 17: A
Cape Verde is located off the western coast of Africa, south of the Azores. It became independent from Portugal in 1975, and aside from a shared official language, has no ties, either politically or geographically, to Brazil.

Question 18: A
UNESCO stands for the United Nations Educational, Scientific and Cultural Organization. One of its roles is to maintain a list of the World Heritage sites, so **A** is the answer. The WHO is the World Health Organisation; UNICEF is the United Nation's Emergency Children's Fund; the OECD is the Organisation for Economic Co-operation and Development, and the WTO is World Trade Organisation.

Question 19: A
Hungary uses the forint, not the euro.

Question 20: A
Direct universal suffrage means all adult citizens have the right to vote. Senators of the Senate of the Republic are elected every 5 years by all Italians aged 25 or older.

Question 21: A
Competition is usually thought of as positive, as it encourages businesses and people to produce goods of a higher quality and lower price, in order to attract as many customers as possible. As a result, **A** is not a principle of the sharing economy.

Question 22: A
The Fields medal is awarded every four years to 2-4 mathematicians younger than 40.

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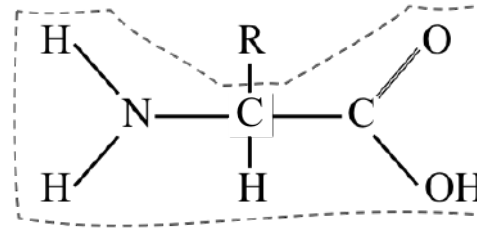
SECTION 2

Question 23: A

Extracellular fluid and cytoplasm are both primarily water, so hydrophobic parts of a molecule will be inside the cell membrane. Only label **3**, which is pointing to the hydrophobic fatty acid "tails" of a phospholipid, fulfils this.

Question 24: A

Draw out the structure of an amino acid and circle the general structure, i.e. everything that is not the R group. This makes the question much easier, as you can now see that **X** encloses the part of the molecule that is common to every amino acid, and **Y** encloses the R group.



Question 25: A

All of these options are correct.

Some people get confused about statement **2**, as some viruses have RNA as their genetic material. Remember, viruses cannot reproduce independently, and must use a host cell, so are not technically living.

Question 26: A

The genes for antibiotic resistance and insect toxin production will not be taken from the *Agrobacterium tumefaciens*, but more likely from organisms that have those genes already. That means statements **3** and **4** are incorrect. Statements **1** and **2** are true, so **A** is the answer.

Question 27: A

The glomerulus is where the process of urine production begins. It is a network of capillaries and acts as a filter, forcing water and other small molecules into the nephron tubule. It is an important structure, but not involved in the reabsorption of water.

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Question 28: A

Bile does not affect the activation energy of lipase but works by emulsifying lipid droplets to increase the surface area over which lipase can work. This means **3** is incorrect, and statements **1**, **2** and **4** are correct.

Question 29: A

The developing foetus does not need to use its lungs to oxygenate blood, as it receives oxygenated blood from the placenta. The hole in the septum allows blood to bypass pulmonary circulation and instead circulate around the body where it is needed.

Question 30: A

DNA winds coils around histones to form a nucleosome, made up of DNA wound around eight histones. Nucleosomes fold and combine to produce a much larger chromosome.

Question 31: A

Acetylcholine binding to the postsynaptic receptor causes sodium channels to open, resulting in a depolarisation. This initiates the movement of calcium ions into the sarcoplasm, which then uncovers binding site of myosin. Consequently, the order is **2**, **1**, **3**.

Question 32: A

HIV is an RNA retrovirus, so does not contain DNA. Viruses don't have ribosomes, but do have capsids, so only statement **1** is correct.

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Question 33: A

The relevant formula is:

$$\text{Actual size} = \frac{\text{Size of image}}{\text{Magnification}}$$

Calculate the actual size of each structure and convert everything to mm:

1. $\frac{4}{4000}$ = 0.001 cm = 0.01 mm
2. 0.5 μm = 0.0005 mm
3. $\frac{6}{20\,000}$ = 0.0003 cm = 0.003 mm
4. 0.14 mm
5. $\frac{3}{400}$ = 0.0075 cm = 0.075 mm

2 is the smallest.

Question 34: A

Circular DNA is common in both bacteria and in yeast cells. The liver cell is more confusing, but remember that it will contain mitochondria, which contains circular DNA.

Question 35: A

Hydrogen bonds are broken by DNA helicase in both processes and are made in both processes, by DNA polymerase in replication and RNA polymerase in transcription. Phosphodiester bonds also form in both processes, as they form the sugar-phosphate backbone of both RNA and DNA.

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Question 36: A

A new species evolved because generations after F2 would not breed with the original species of finch. The *G. fortis* was smaller than *G.conirostris,* and they had very different songs, which suggests that that later generations could not identify the original species, and as a result, they never mated. This is pre-zygotic, not post-zygotic, reproductive isolation, so statement **2** is correct and **3** is incorrect. It is not clear whether the speciation was sympatric or not, as the passage does not specify the location of the populations. For sympatric speciation to occur, the populations must live in exactly the same area of the island. That cannot be inferred, so we cannot say **1** is correct.

Question 37: A

A single base mutation could cause many issues, or none at all (as often the third amino acid in a codon is irrelevant to the code – this is degeneracy). A change to the codon could change the amino acid it codes for in the primary structure. This in turn could affect the bonding between R groups, altering the tertiary structure of the protein. Alternatively, the mutation could code for a stop codon, which would shorten the final protein.

Question 38: A

Catabolism is defined as the breakdown of complex molecules to form smaller ones. Of the options, only **A** meets this definition, as when NADH is oxidised it forms NAD and a proton.

Question 39: A

A haploid number of 4 means four sets of chromosomes are present, indicating a diploid number of 8. During meiosis, the number of chromosomes doubles so that there is sufficient genetic material to produce four daughter cells. This means there will be 16 chromosomes, so the answer is **A**.

Question 40: A

Rhodopsin breaks down upon stimulus of a rod cell; it is not formed. It is made up of opsin and retinal. An opsonin is a substance that binds to structures on cells and pathogens to make them more susceptible to phagocytosis, and retinol is vitamin A. Retinal is a derivative of vitamin A, but they are not the same and should not be confused.

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SECTION 3

Question 41: A

Br_2 represents a bromine molecule, or two bromine atoms bound to each other with a covalent bond. It is not a compound, as compounds are molecules of two or more elements.

Question 42: A

1 is correct as no more sucrose can dissolve, so the solution is saturated. **2** is incorrect as there is no relevant information given about the freezing point. **3** is incorrect as sucrose is polar. **4** is correct, as sucrose is dissolving in water, so it is the solute.

Question 43: A

A magnesium ion has a charge of 2+ so it will bind two hydroxide ions. Consequently, the formula of magnesium hydroxide is $Mg(OH)_2$. This rules out **B**, **C** and **D,** leaving **A** and **E**. **E** is not a balanced equation, so **A** must be the answer.

Question 44: A

The weakest intermolecular forces are Van der Waal forces – hydrogen bonds and permanent dipole interactions are stronger. As a result, the weakest intermolecular forces will be formed by either CH_4 or CO_2, as they are the only non-polar molecules. CH_4 is smaller, so forms weaker intermolecular forces.

Question 45: A

Atomic number = number of protons

Mass number = number of protons + number of neutrons.

Therefore, the number of neutrons can be given by the atomic number - the mass number:

$2x + 6 - x = x + 6$

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Question 46: A

To calculate an oxidation state, calculate the change in the number of electrons. Remember that the sum of the oxidation states in a molecule is 0 and the sum of the oxidation states in an ion is equal to the charge of the ion.

VCl_4: $V + 4(-1) = 0 \rightarrow V = 4$
VO^{2+}: $V + (-2) = 2 \rightarrow V = 4$
VO_2: $V + 2(-2) = 0 \rightarrow V = 4$
VO_3^-: $V + 3(-2) = -1 \rightarrow V = 5$
V_2O_5: $2V + 5(-2) = 0 \rightarrow V = 5$

The only pair where vanadium has the same oxidation state is VCl_4 and VO^{2+}, so **A** is the answer.

Question 47: A

Structural isomerism is present when molecules have the same molecular formula, but different structural formulae. Both molecules in all the pairs have the same molecular formula. However, in the second pair, the methyl group is attached to the same carbon (the third carbon) on both molecules, so they are not structural isomers. Pairs **1** and **3** do represent structural isomers however, so **A** is correct.

Question 48: A

-COOH is a carboxylic acid group, not an alcohol and ketone put together. $-NH_3$ is an amine group, not an amide. -HS is a thiol group, so **A** is the answer.

Question 49: A

The value of the equilibrium constant can only be changed by a change in temperature. Changing the pressure or adding a catalyst will not affect it. We know from the ΔH that the forward reaction is exothermic, so a decrease in temperature will increase the value of $[P]^2$, so the answer is **A**.

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Question 50: A

Even if molecules have dipoles, they will not have a permanent dipole if they are symmetric. The only molecule listed that is asymmetric is NF_3, due to the lone pair of electrons present on the nitrogen. Therefore, only NF_3 has a permanent dipole.

Question 51: A

Remember pH is based on a logarithmic scale. The formula for pH is:

$$pH = -\log[H^+]$$

You can rearrange this to find the formula that gives the concentration of hydrogen ions at a given pH:

$-pH = \log[H^+]$

So, $[H^+] = 10^{-pH}$

Substituting in pH = 2 and pH = 4:

$$\frac{X([H^+])}{Y([H^+])} = \frac{10^{-2}}{10^{-4}} = \frac{0.01}{0.0001} = 100$$

X has a hydrogen ion concentration 100 times greater than Y.

Question 52: A

Start by calculating the number of moles of sulfuric acid present in the 25 cm^3, using the formula: Number of moles = Concentration x Volume:

$$n(H_2SO_4) = \frac{25}{1000} \times 0.40 = 0.01 \text{ mol}$$

As per the chemical equation, there are two molecules of sodium hydroxide for every molecule of sulfuric acid, so there are 0.02 mol of sodium hydroxide in 40cm^3.

Work out the concentration of the NaOH in mol L^{-1}:

$$0.02 \div \frac{40}{1000} = 0.5 \text{ mol } L^{-1}$$

Convert the units to g L^{-1}:

$0.5 \times 40 = 20 \text{ g } L^{-1}$

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SECTION 4

Question 53: A

$8^{2x+3} \times 4^{-3x} = 2^{x+3}$

$2^{3(2x+3)} \times 2^{2(-3x)} = 2^{x+3}$

$2^{3(2x+3)+2(-3x)} = 2^{x+3}$

$3(2x+3) + 2(-3x) = x + 3$

$6x + 9 - 6x = x + 3$

$9 = x + 3$

$x = 6$

Question 54: A

$$= \frac{2}{2+\sqrt{3}}$$

$$= \frac{2}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$$

$$= \frac{2(2-\sqrt{3})}{(2+\sqrt{3})(2-\sqrt{3})}$$

$$= \frac{4-\sqrt{3}}{4+2\sqrt{3}-2\sqrt{3}-3}$$

$$= \frac{4-\sqrt{3}}{1} = 4-\sqrt{3}$$

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Question 55: A

Start by completing the square:

$y = 2x^2 + 5x - 2$

$y = 2\left(x + \frac{5}{2 \times 2}\right)^2 + \left(-2 - \frac{5^2}{4 \times 2}\right)$

$y = 2\left(x + \frac{5}{4}\right)^2 - \frac{41}{8}$

$y = 2\left(x + \frac{5}{4}\right)^2 - \frac{41}{8}$

The turning point is also the minimum point, and so it occurs when the value of y is at its lowest.

As $2\left(x + \frac{5}{4}\right)^2$ is never negative, the minimum value of y is $-\frac{41}{8}$.

$y = -\frac{41}{8}$ when $2\left(x + \frac{5}{4}\right)^2 = 0$.

$2\left(x + \frac{5}{4}\right)^2 = 0$

$x = -\frac{5}{4}$ at the turning point.

Therefore, the coordinates of the turning point are $\left(-\frac{5}{4}, -\frac{41}{8}\right)$.

Question 56: A

The mean will be given by: $\frac{\text{Number of meals in total}}{\text{Number of students}}$

Substitute in the information that we know:

$\frac{2 \times 39 + 36x}{39 + 36} = \frac{16}{5}$

$78 + 36x = \frac{16 \times 75}{5}$

$36x = 240 - 78$

$x = \frac{162}{36} = \frac{9}{2} = 4\frac{1}{2}$

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Question 57: A

1. Correct.
2. Correct.
3. Incorrect. A concave parabolic mirror will produce an image the right way up if the object is closer to the mirror than F is.
4. Incorrect. A virtual image will be produced if the object is closer to the mirror than F.
5. Incorrect. If the object is farther from the mirror than F is, the image will be smaller than the object.

Question 58: A

Specific latent heat of evaporation is defined as the energy need to change 1kg of a liquid into a gas at its boiling point without changing the temperature.

The equation for it is: Change in energy = Mass × Specific latent heat

First, work out the energy change. If 100 W converts 200 g of liquid to in 1600 s, and 1 Watt is 1 Joule per second, the energy change in J is 100 × 1600 = 160 000 J.

$$\frac{160\ 000}{200} = 800\ J/g$$

Question 59: A

Use the equation F = ma. T is the resultant force, so T = ma.

The vertical acceleration working in the opposite direction to gravity. The signs get confusing here: gravity is working against the thrust, so you subtract it, but because it is acting in the opposite direction, it is also negative:

$T = m(a - -g)$

$T = m(a + g)$

Rearrange the equation to make a the subject:

$$\frac{T}{m} = a + g$$

$$a = \frac{T}{m} - g$$

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Question 60: A

We know that the boat is moving horizontally across the river at 4 m/s, and that the river is flowing vertically at a speed of 3 m/s. You can imagine this as a right-angled triangle with 4 as the base and 3 as the height. The speed at which the boat is moving will therefore be given by the hypotenuse.

$\sqrt{3^2 + 4^2} = \sqrt{9 + 16} = \sqrt{25} = 5$ m/s

Calling the angle that the boat is travelling x, we can calculate the value of x using the inverse cos function.

$$\cos(x) = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\cos(x) = \frac{4}{5}$$

$$x = \cos^{-1}\frac{4}{5}$$

Therefore, the speed = 5.0 m/s and the angle = $\cos^{-1}\frac{4}{5}$.

END OF PAPER

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FINAL ADVICE

Arrive well rested, well fed and well hydrated

The IMAT is an intensive test, so make sure you're ready for it. Ensure you get a good night's sleep before the exam (there is little point cramming) and don't miss breakfast. If you're taking water into the exam, then make sure you've been to the toilet before, so you don't have to leave during the exam. Make sure you're well rested and fed in order to be at your best!

Move on

If you're struggling, move on. In the time it takes to answer on hard question, you could gain three times the marks by answering the easier ones. Be smart to score points – especially in section 2 where some questions are far easier than others.

Take a moment to calm down

It is normal to be nervous when you arrive to take the exam. Nerves can be good – they can serve as a useful motivator for your revision and help you focus. However, too much and they can be counterproductive. If you are really anxious, there is absolutely nothing wrong with taking twenty seconds at the beginning of the test to take a deep breath and focus on what you need to do. Those few seconds can help you focus and avoid making silly mistakes, like misreading a critical thinking question or forgetting a minus sign in section 4.

Remember the positives

Although this book will help you to be the most prepared you can be, it is rare that any exam goes perfectly! Expecting to get 100% stops you making tactical decisions to move on and maximise your marks. Also, remember that it is easy to walk out the exam and fixate on the mistakes you made. Make an effort to think about the questions that you know you did well on, or that tricky chemistry question that you weren't sure about and then it just clicked. This will also reduce your nerves in the lead up to results being released.

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Think of the bigger picture

Medicine is a truly amazing career to pursue and there are not many jobs which are as fulfilling and as intellectually stimulating as being a healthcare worker. However, it is also highly competitive and very challenging. You will be expected to sit exams all the way through your career. Most doctors don't do everything perfectly! Some of the best doctors failed to get into medical school on their first attempt or had to retake one or some of their exams. That does not stop them from being intelligent, empathetic, and all-round good doctors. If your exam does not go to plan, remember that it is one year out of a very successful and long career. Think about what went wrong, how you could improve and use your experience to come back next year as a better and more prepared candidate. This book, and the other resources UniAdmissions offers, will help you enormously.

AFTERWORD

Remember that the route to a high score is your approach and practice. Don't fall into the trap that "*you can't prepare for the IMAT*"– this couldn't be further from the truth. With knowledge of the test, time-saving techniques and plenty of practice you can dramatically boost your score.

Work hard, never give up and do yourself justice.

Good luck!

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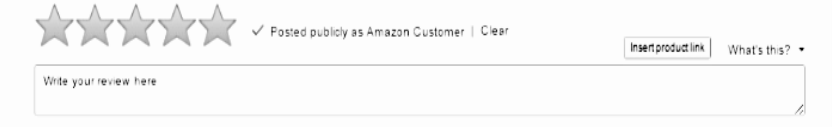

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